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Procedures for the Preparation of Emission Inventories for Volatile Organic Compounds
Volume I. Second Edition

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16. ABSTRACT

Procedures are described for compiling emission inventories of volatile organic compounds (VOC) for use in less data-intensive models such as rollback and the Empirical Kinetic Modeling Approach (EKMA). Such inventories generally represent annual emissions (perhaps with some seasonal information) and are compiled for larger geographical areas such as counties.

The basic inventory elements--planning, data collection, emission estimates, and reporting--are all discussed. No single prescriptive methodology is presented; rather, a set of procedures is described so that the agency may choose the most appropriate techniques to meet its needs in its ozone program. Various examples are included to aid the agency in the understanding and utilization of this document.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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Procedures for the Preparation of Emission Inventories for Volatile Organic Compounds

Volume I

Second Edition

Monitoring and Data Analysis Division
Office of Air Quality Planning and Standards

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

September 1980

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1.0 INTRODUCTION

1.1 PURPOSE

Ozone is photochemically produced in the atmosphere when volatile organic compounds (VOC) are mixed with nitrogen oxides (NO_x) in the presence of sunlight. In order for an air pollution control agency to develop and implement an effective ozone control strategy, information must be compiled on the important sources of these precursor pollutants. This is the role of the emission inventory--to tell the agency what types of sources are present in an area, how much of each pollutant is emitted, and what types of processes and control devices are employed at each plant. Ultimately, the inventory is used in conjunction with an appropriate source/receptor model to relate emissions of VOC and NO_x to subsequent levels of ozone in the ambient air.

This document provides guidance to those engaged in the planning of a VOC emission inventory and to those charged with the actual inventory compilation effort. It is published in two major volumes. Volume I is devoted to presenting step by step procedures for compiling the basic VOC emission inventory. In this context, "basic" refers to an inventory that provides the type of data needed for the simplest photochemical ozone source/receptor models, such as the Empirical Kinetic Modeling Approach (EKMA).[1,2] Generally, the basic inventory will produce annual or seasonal emission estimates of reactive VOC for relatively large areas. Spatial resolution in such an inventory will be at the county or equivalent level. This volume outlines the procedures that an agency should consider in compiling an emission inventory when not anticipating use of a photochemical atmospheric simulation model.

Volume II describes techniques for compiling inventories of hourly emissions allocated to subcounty grids.[3] Reactive VOC and NO_x in such inventories are allocated into various classes or species categories. Such degree of detail is required so that the inventory can be input to various photochemical atmospheric simulation models.

Volume I contains a set of general technical procedures rather than a single prescriptive guideline for completing a VOC emission inventory. Because users' needs may vary from area to area, and because certain techniques may be applicable in some areas and not in others, no one prescriptive methodology is recommended for use in all circumstances. Rather, a number of optional techniques representing various levels of detail are presented for compiling the inventory. In addition, advantages and disadvantages of these techniques are weighed to help the agency to decide what level of detail will be sufficient to meet its needs and objectives and, at the same time, what can be accomplished given the constraints on the inventory compilation effort.

This document is not intended to set forth the Environmental Protection Agency's requirements for inventory development or inventory data submittals. Moreover, this document does not prescribe what control measures should be considered in a specific inventory effort such as Reasonable Available Control Technology (RACT). Although these topics are mentioned in Volume I for discussion and example purposes, the reader should consult the Environmental Protection Agency's State Implementation Plan (SIP) regulations to determine the specific emission inventory and control strategy requirements applicable to particular programs.[4]

1.2 CONTENTS OF VOLUME I

The major emphasis of this guideline is on the development of a VOC emission inventory that is useful in various facets of an ozone control program. Thus, when describing the planning and implementation of an inventory, the bulk of the discussion herein centers on issues that relate to developing a strategy for ozone control. The VOC inventory can, of course, be useful to the agency in other areas, such as in programs dealing with specific toxic organic chemicals. The procedures in this document will be generally applicable to developing VOC emission inventories for use in other program areas and also to developing inventories of other pollutants than VOC, including NO_x.

Volume I is divided into chapters that correspond to the major steps necessary in the basic inventory effort. Chapter 2 discusses planning, an important and often neglected aspect of inventory effort. Various planning considerations are explored, and guidance is offered to the agency to help it decide which inventory approach should ultimately be pursued, given the resources it has available. Included in Chapter 2 is an overview of the basic "how to" procedures presented in the remainder of the document. A generalized flowchart is presented which outlines the major activities necessary in the basic emission inventory compilation effort.

Chapter 3 describes the various ways source and emissions data can be collected on individual sources for use in the point source inventory. Direct plant contacts of various types, including questionnaires and plant visits, represent the preferred approach for data collection. Approaches are also discussed involving publications and other information sources.

Chapter 4 describes procedures for making collective activity level and emission estimates for those area sources generally too small or too numerous to be considered individually in the point source inventory. Such procedures include making field surveys of actual area source activity as well as the use of surrogate indicators of area source activity such as population and employment.

Chapter 6 discusses procedures for making emission estimates based on the source data collected from the plant contacts, field surveys and questionnaires. Procedures for handling source test data and performing material balances are described. The basic use of emission factors is reviewed, including cases where adjustments can be made to reflect specific source parameters and environmental conditions. Also presented are procedures for "scaling up" the inventory to account for missing sources as well as for adjusting the VOC emissions to exclude nonreactive components. Finally, seasonal adjustment of the inventory is discussed along with techniques for projecting emission totals.

Chapter 7 discusses reporting, i.e., the presentation of inventory information in various ways useful to the agency. Reporting can include listings of the individual data items contained in the inventory files as well as various kinds of summary manipulations.

Appendix A contains a glossary of important terms used in conjunction with VOC emission inventories. These definitions may give persons not familiar with VOC inventories a better understanding of this document and of compiling such inventories in their areas. Appendix B provides a detailed listing of point source process emission points. Appendix C contains summary descriptions of the VOC sources for which EPA has or will establish control techniques guideline (CTG).

Appendix D includes an example of a cover letter and questionnaire used in mailing surveys for point source inventories. Appendix E provides a number of examples of emission inventory documentation. Appendix F contains summary descriptions of the NEDS and EIS/P&R inventory systems available from EPA for general use.

Comments and suggestions regarding the general technical content of this document should be brought to the attention of the Director, Monitoring and Data Analysis Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

The reader should note that no procedures are presented in Chapter 5 for compiling inventories of emissions from highway vehicles. Recommended techniques are being developed and will be in future editions of this document. In the meantime, for information on this subject, the reader should contact EPA's Office of Transportation and Land Use Policy, ANR-443, 401 M Street SW, Washington, DC 20460.

References for Chapter 1.0

1. Uses, Limitations and Technical Basis of Procedures for Quantifying Relationships Between Photochemical Oxidants and Precursors, EPA-450/2-77-021a, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1977.

2. User's Manual for Kinetics Model and Ozone Isopleth Plotting Package, EPA-600/8-78-014a, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1978.

3. Procedures for the Preparation of Emission Inventories for Volatile Organic Compounds, Volume II, EPA-450/4-79-018, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

4. Emission Industry Requirements for 1982 Ozone State Implementation Plans, Draft, EPA-450/4-80-016, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1980.

2.0 VOC INVENTORY OVERVIEW AND PLANNING

2.1 OVERVIEW OF INVENTORY PROCEDURES

The next several chapters present the "how to" for compiling the basic volatile organic compound emission inventory. Emphasis is given to methodologies that produce annual emission estimates of reactive VOC for broad geographical areas and which can be resolved to the county level. Some discussion is devoted to adjusting an annual inventory of VOC emissions to reflect conditions during the ozone season, which is the time interval of primary interest in photochemical ozone production.

Four basic steps are involved in the preparation of a VOC emission inventory. The first is planning. The agency should define the need for the VOC inventory as well as the constraints that limit the ability of the agency to produce it. The various planning aspects discussed in the following sections of this chapter should all be considered prior to initiation of the actual data gathering phases of the inventory effort. All proposed procedures and data sources should be documented at the outset and be subjected to review by all potential users of the final inventory, including the management and technical staff of the inventory agency.

The second basic step is data collection. A major distinction involves which sources should be considered point sources in the inventory and which should be considered area sources. Fundamentally different data collection procedures are used for these two source types. Individual plant contacts are used to collect point source data, whereas collective information is generally used to estimate area source activity. Much more detailed data are collected and maintained on point sources.

The third basic step in the inventory compilation effort involves an analysis of data collected and the development of emission estimates for each source. Emissions will be determined individually for each point source, whereas emissions will generally be determined collectively for each area source category. Source test data, material balances, and emission factors are all used to make these estimates. Adjustments are required to exclude nonreactive VOC and to make the resulting emission totals representative of the ozone season. A special adjustment called "scaling up" is necessary in some cases to account for sources not covered in the point source inventory. Estimates of projected emissions must also be made as part of this step.

The fourth step is reporting. Basically, reporting involves presenting the inventory data in a format that serves the agency in the development and implementation of an ozone control program or other regulatory effort. Depending on the capabilities of the inventory data handling system, many kinds of reports can be developed that will be useful in numerous facets of the agency's ozone control effort.

Figure 2.1-1 provides a generalized flowchart outlining the major elements and activities needed in the compilation of the basic VOC emission inventory. Each of these activities is described in detail in the following chapters, except for the various aspects of planning, which are discussed in the following sections of this chapter.

2.2 GENERAL PLANNING CONSIDERATIONS

Before an agency initiates the actual compilation of the VOC emission inventory, the agency's management and technical staff must carefully evaluate what its specific inventory needs are with respect to ozone strategy development and must define what objectives it expects the inventory to meet. Further, once agency management and staff have determined what its needs are, and what specific objectives they expect the VOC emission inventory to meet in the agency control program, a number of considerations should be made before actually initiating the inventory. These considerations involve various requirements and constraints--technical, economic, and legal--that must be accounted for during the planning stages of the inventory effort. Depending on the agency's needs, the time and resources expended in dealing with these various requirements and constraints will vary. This chapter provides guidance to help agency management and technical staff decide how these various considerations can best be addressed with available resources to design and complete the emission inventory.

During the planning step of the VOC emission inventory, the agency should address a number of questions which occur in developing the inventory. The following questions should have been answered prior to initiating the collection phase of the inventory effort.

° What are the end uses of the VOC emission inventory (i.e., State Implementation Plan [SIP] submittal, community or constituency reports, air quality research, etc.)?

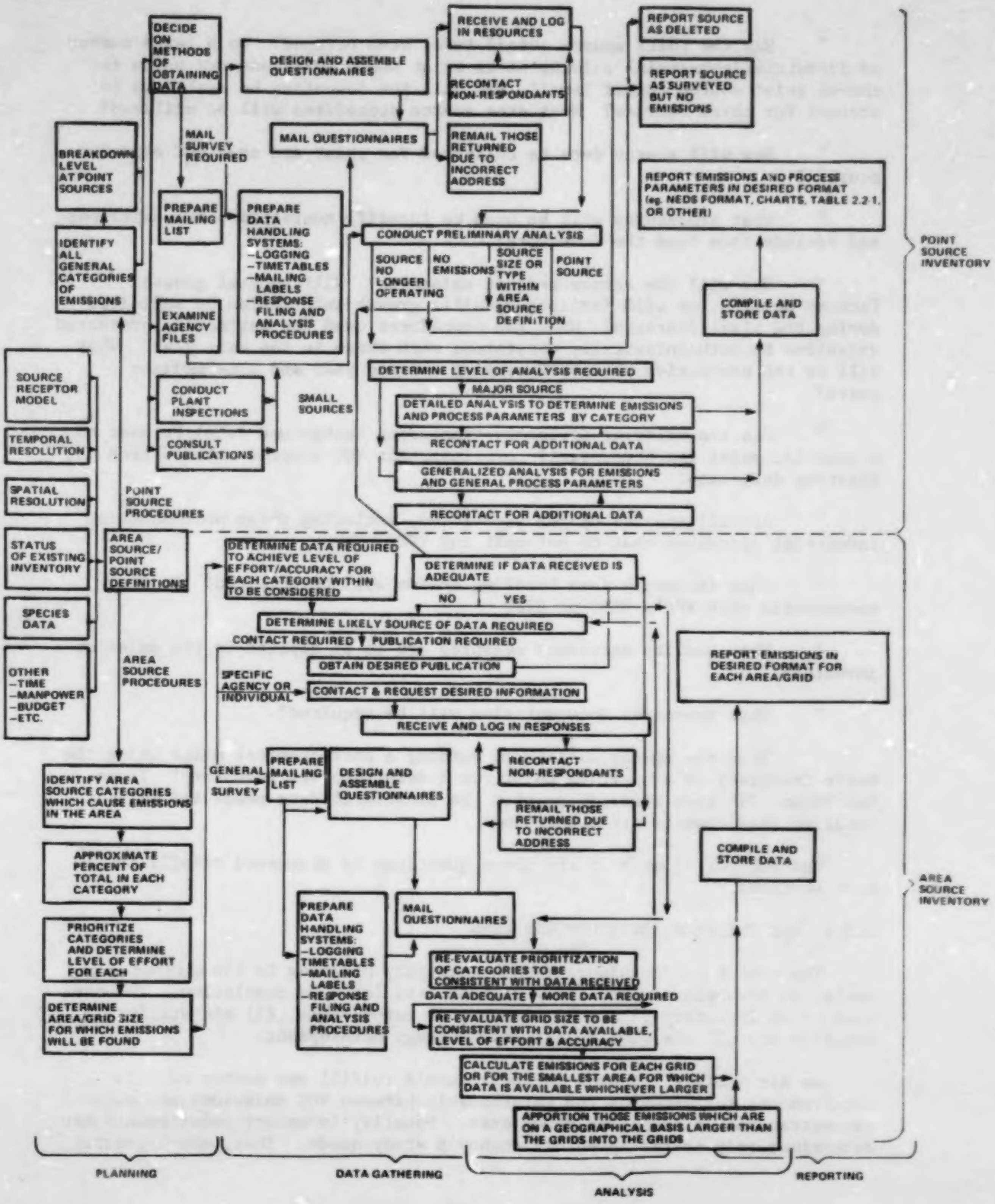
° Have the source categories been defined that will be included in the inventory? Are these categories compatible with the source and emissions information available? Are they detailed enough to facilitate the making and reporting of control strategy projections and to readily define emissions of nonreactive VOC?

° What are the manpower and budget allocations required and available for the inventory effort?

° Has the geographical area been outlined that will be inventoried? What level of spatial resolution is needed for the source/receptor model that will be used? What are the smallest political jurisdictions within the inventory area for which area source activity level information is readily available?

° What inventory base year will be selected which is appropriate for the inventory end use?

° What sources will have seasonally varying emissions? Will the inventory be seasonally adjusted? Will annual or daily emissions be compiled?



DECIDE ON METHODS OF OBTAINING DATA
DESIGN AND ASSEMBLE QUESTIONNAIRES
RECEIVE AND LOG IN RESOURCES
RECONTACT NON-RESPONDANTS
REPORT SOURCE AS DELETED
REPORT SOURCE AS SURVEYED BUT NO EMISSIONS
MAIL SURVEY REQUIRED
MAIL QUESTIONNAIRES
REMAIL THOSE RETURNED DUE TO INCORRECT ADDRESS
BREAKDOWN LEVEL AT POINT SOURCES
REPORT EMISSIONS AND PROCESS PARAMETERS IN DESIRED FORMAT (eg. NEDS FORMAT, CHARTS, TABLE 2.2-1, OR OTHER)
PREPARE MAILING LIST
PREPARE DATA HANDLING SYSTEMS: –LOGGING –TIMETABLES –MAILING LABELS –RESPONSE FILING AND ANALYSIS PROCEDURES
IDENTIFY ALL GENERAL CATEGORIES OF EMISSIONS
CONDUCT PRELIMINARY ANALYSIS
SOURCE NO LONGER OPERATING
NO EMISSIONS
SOURCE SIZE OR TYPE WITHIN AREA SOURCE DEFINITION
POINT SOURCE
POINT SOURCE INVENTORY
COMPILE AND STORE DATA
EXAMINE AGENCY FILES
DETERMINE LEVEL OF ANALYSIS REQUIRED
MAJOR SOURCE
SOURCE RECEPTOR MODEL
CONDUCT PLANT INSPECTIONS
SMALL SOURCES
DETAILED ANALYSIS TO DETERMINE EMISSIONS AND PROCESS PARAMETERS BY CATEGORY
TEMPORAL RESOLUTION
CONSULT PUBLICATIONS
RECONTACT FOR ADDITIONAL DATA
GENERALIZED ANALYSIS FOR EMISSIONS AND GENERAL PROCESS PARAMETERS
SPATIAL RESOLUTION
POINT SOURCE PROCEDURES
RECONTACT FOR ADDITIONAL DATA
STATUS OF EXISTING INVENTORY
AREA SOURCE/ POINT SOURCE DEFINITIONS
DETERMINE DATA REQUIRED TO ACHIEVE LEVEL OF EFFORT/ACCURACY FOR EACH CATEGORY WITHIN TO BE CONSIDERED
DETERMINE IF DATA RECEIVED IS ADEQUATE
NO
YES
SPECIES DATA
DETERMINE LIKELY SOURCE OF DATA REQUIRED
CONTACT REQUIRED
PUBLICATION REQUIRED
REPORT EMISSIONS IN DESIRED FORMAT FOR EACH AREA/GRID
OTHER –TIME –MANPOWER –BUDGET –ETC.
AREA SOURCE PROCEDURES
OBTAIN DESIRED PUBLICATION
SPECIFIC AGENCY OR INDIVIDUAL
CONTACT & REQUEST DESIRED INFORMATION
RECEIVE AND LOG IN RESPONSES
IDENTIFY AREA SOURCE CATEGORIES WHICH CAUSE EMISSIONS IN THE AREA
GENERAL SURVEY
PREPARE MAILING LIST
DESIGN AND ASSEMBLE QUESTIONNAIRES
RECONTACT NON-RESPONDANTS
REMAIL THOSE RETURNED DUE TO INCORRECT ADDRESS
APPROXIMATE PERCENT OF TOTAL IN EACH CATEGORY
COMPILE AND STORE DATA
AREA SOURCE INVENTORY
PREPARE DATA HANDLING SYSTEMS: –LOGGING TIMETABLES –MAILING LABELS –RESPONSE FILING AND ANALYSIS PROCEDURES
MAIL QUESTIONNAIRES
PRIORITIZE CATEGORIES AND DETERMINE LEVEL OF EFFORT FOR EACH
RE-EVALUATE PRIORITIZATION OF CATEGORIES TO BE CONSISTENT WITH DATA RECEIVED
DATA ADEQUATE
MORE DATA REQUIRED
DETERMINE AREA/GRID SIZE FOR WHICH EMISSIONS WILL BE FOUND
RE-EVALUATE GRID SIZE TO BE CONSISTENT WITH DATA AVAILABLE, LEVEL OF EFFORT & ACCURACY
CALCULATE EMISSIONS FOR EACH GRID OR FOR THE SMALLEST AREA FOR WHICH DATA IS AVAILABLE WHICHEVER LARGER
APPORTION THOSE EMISSIONS WHICH ARE ON A GEOGRAPHICAL BASIS LARGER THAN THE GRIDS INTO THE GRIDS
PLANNING
DATA GATHERING
ANALYSIS
REPORTING

Figure 2.1-1. Flow chart of VOC emission inventory compilation activities (Radian, 1977).

- Has the point source cutoff level been defined? Do a large number of industrial/commercial solvent users exist whose emissions are below the chosen point source cutoff level? How will the inventory be scaled up to account for these sources? What area source procedures will be utilized?

- How will source data be collected for point and area VOC emission sources?

- What procedures will be used to identify nonreactive VOC emissions and exclude them from the inventory?

- How will the agency project emissions? Will general growth factors be used, or will facility-specific growth information be solicited during the plant contacts? Will the procedures used for estimating projected emissions be methodologically consistent with those in the base year? What will be the projection period, including the end year and intermediate years?

- Can the existing inventory (including background data) be used as a starting point for the update? Are important VOC sources omitted from the existing data base?

- Are all sources of NO_x identified, including those noncombustion industrial processes that do not emit any VOC?

- What inventory data handling system will be utilized? Is it compatabile with EPA's NEDS or EIS?

- What quality assurance measures are to be applied to the emission inventory?

- What inventory documentation will be required?

- Does the agency anticipate running a photochemical model using the basic inventory as a starting point for a more resolved inventory? If so, has Volume II[1] been studied, so that the additional data needs and data handling requirements are understood?

The subject of each of the above questions is discussed briefly in the next sections.

2.2.1 VOC EMISSION INVENTORY END USES

The most basic consideration in inventory planning is the ultimate use(s) of the emission inventory will be used for upon completion. The end uses of an inventory fall into two general categories: (1) air quality research and (2) air quality control strategy development.

An air quality research inventory could fulfill any number of data requirements for studying the relationship between VOC emissions and ozone concentrations in any given study area. Usually, inventory requirements are determined only by the inventory agency's study needs. Thus, most research inventories are unrestricted, allowing the agency unlimited consideration of inventory methodologies, data reporting formats, projection techniques and the other items discussed in the remaining sections of this chapter.

While air quality or emission control strategy inventories can be initiated by an individual agency, most are undertaken as legal requirements which usually set forth specific procedures to be used. The most commonly required inventory is the SIP inventory. Requirements for these inventories are outlined in EPA guidance 12 to 24 months before the SIP submittals are to be completed. When using this volume to plan and develop a SIP VOC inventory, it is suggested that applicable EPA guidance be consulted to avoid employing inappropriate procedures.

In addition to fulfilling legal requirements, a good VOC control strategy inventory can be very useful to an air pollution agency. On a day-to-day basis, the point source listing of the inventory can be useful in investigating citizen complaints and possible violations of emission codes. In the long term, an accurate compilation of emissions in the inventory will lead to better assessment of the impact of community growth on air quality. By considering what uses the VOC emissions inventory will serve, the inventory can achieve any program objective, whether research or regulatory in nature.

2.2.2 SOURCES OF VOC EMISSIONS

An important consideration affecting emission accuracy is whether the agency has included all sources of VOC in its inventory. Table 2.2-1 presents those major sources of VOC that, at a minimum, should be considered in the inventory. Some sources in this table are generally considered point sources, some are generally handled collectively as area sources, while others, such as drycleaners, can be either point or area sources, depending on the size of each operation and the particular cutoff made between point and area sources.

The entries in Table 2.2-1 describe general source categories and do not list all of the emitting points that may be associated with any of the particular source categories. For example, petroleum refining operations actually include many emitting points ranging from process heaters to individual seals and pumps. Appendix B contains a more detailed listing of processes included in the categories shown in Table 2.2-1. General process and emissions information on these sources may be obtained from AP-42, Compilation of Air Pollution Emission Factors[2] (including supplements) and in Appendix C of this document.

Those stationary sources of VOC for which EPA has published or will publish Control Techniques Guidelines (CTG) are included in the categories listed in Table 2.2-1 and Appendix B. Summary information on many of these sources is presented in Appendix C. Additional process, emission, and control device information is available on these sources in the CTG documents which are or will be available from the Director, Emission Standards and Engineering Division, Mail Drop 13, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Many of these documents are cited in the following chapters of this volume.

Table 2.2-1. Volatile Organic Compound (VOC) Emission Sources.

STORAGE, TRANSPORTATION AND MARKETING OF VOC

- Oil and Gas Production & Processing
- Gasoline and Crude Oil Storage[1]
- Synthetic Organic Chemical Storage & Transfer
- Ship and Barge Transfer of VOC
- Barge and Tanker Cleaning
- Bulk Gasoline Terminals[2]
- Gasoline Bulk Plants[3]
- Service Station Loading (Stage I)
- Service Station Unloading (Stage II)
- Others

INDUSTRIAL PROCESSES

- Petroleum Refineries
- Lube Oil Manufacture
- Organic Chemical Manufacture
- Inorganic Chemical Manufacture
- Fermentation Processes
- Vegetable Oil Processing
- Pharmaceutical Manufacture
- Rubber Tire Manufacture
- Plastic Products Manufacture
- Rubber Tire Manufacture
- SBR Rubber Manufacture
- Textile Polymers & Resin Manufacture
- Synthetic Fiber Manufacture
- Iron and Steel Manufacture
- Others

INDUSTRIAL SURFACE COATING

- Large Appliances
- Magnet Wire
- Automobiles
- Cans
- Metal Coils
- Paper
- Fabric
- Metal Wood Products
- Miscellaneous Metal Products
- Plastic Parts Painting
- Large Ships
- Large Aircraft
- Others

NON-INDUSTRIAL SURFACE COATING

- Architectural Coatings
- Auto Refinishing
- Others

OTHER SOLVENT USE

- Degreasing
- Dry Cleaning
- Graphic Arts
- Adhesives
- Cutback Asphalt
- Solvent Extraction Processes
- Consumer/Commercial Solvent Use
- Other

OTHER MISCELLANEOUS SOURCES

- Fuel Combustion
- Solid Waste Disposal
- Forest, Agricultural, and Other Open Burning
- Pesticide Application
- Waste Solvent Recovery Processes
- Stationary Internal Combustion Engines

MOBILE SOURCES

- Highway Vehicles
  - a. Light Duty Automobiles
  - b. Light Duty Trucks
  - c. Heavy Duty Gasoline Trucks
  - d. Heavy Duty Diesel Trucks
  - e. Motorcycles
- Off Highway Vehicles
  - Rail
  - Aircraft
  - Vessels

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[1] Includes all storage facilities except those at service stations and bulk plants.

[2] Loading tank trucks and rail cars.

[3] Storage and transfer operations.

2.2.3 EMISSION INVENTORY MANPOWER REQUIREMENTS

To ensure that sufficient resources have been allocated to achieve good results with an inventory effort, cost and manpower requirements should be evaluated in the planning stage of the project. Technical manpower and budget allocations required will be a function of the number and type of sources to be inventoried, the pollutants being inventoried, and the desired data base detail. These inputs, in turn, will be affected by the inventory end use, the size of the inventory area, and data handling capabilities. Administrative and secretarial support will be a function of the technical manpower and budget allocations determined by all of the above factors.[3,4]

Since cost and manpower requirements will vary for each inventory effort, manpower and budget allocations should be determined case by case. When an agency has conducted inventories regularly, its past experience can be used to estimate requirements. If an agency desires a more detailed determination of requirements, a computer model[4] is available from EPA which estimates technical and administrative costs associated with emission inventories. To use the model, or to obtain additional information, contact an EPA Regional Office or the Control Programs Operations Branch, Control Programs Development Division, MD-15, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

2.2.4 GEOGRAPHICAL AREA

When planning a VOC emissions inventory, the responsible agency must determine geographical boundaries within which emissions will be identified. Statewide inventories provide a broad comprehensive data base which can be useful but which require increased data handling. Historically, VOC inventory efforts have often been confined to urban areas. Whatever area an agency decides to inventory, the decision should be based on meteorological and air quality data as well as on control strategy considerations.

Because ozone can form as a result of photochemical reactions many miles downwind from the precursor pollutant sources, a fairly broad area should be covered by a VOC emissions inventory. At a minimum, the urban and suburban areas should be encompassed. Ideally, the inventory area should include (1) all major emission sources that may affect the urban area, (2) areas of future industrial, commercial and residential growth, (3) as many ambient pollutant monitoring stations as possible, and (4) downwind receptor sites of interest. In this last regard, the inventory area should encompass areas downwind of the urban area where peak ozone levels occur. In general, the area inventoried for a less data intensive source/receptor model such as EKMA[5] should be the same as the area that needs to be covered for use in a photochemical model.

Modeling considerations are not the only factors influencing the designation of the area covered by the inventory. In many cases the inventory area will be prescribed to follow certain existing political boundaries. Most commonly, county boundaries are followed. In certain cases, however, other jurisdictions will be considered, such as cities, towns, townships, or parishes. Typically, the inventory area includes a collection of such jurisdictions representing air basins or at least areas enduring common air pollution problems. Air Quality Control Regions[6] are examples of areas that are used for inventory compilation purposes in ozone control programs.

In cases where the inventory area has not been prescribed, and if uncertainties exist about future land use or the effect of meteorological conditions, the agency should include as much area as possible. In this way, a subset of the emission inventory can be used when the modeling and control strategy analyses are subsequently made.

2.2.5 SPATIAL RESOLUTION

Because the less data intensive source/receptor relationships such as EKMA are not sensitive to changes in the location of emissions, data compiled at the county (or county equivalent) level generally provide sufficient spatial resolution. The county limits are logical boundaries for compiling an emission data base for two reasons. The first is because of the area wide nature of the ozone problem. Ozone is generally not a localized problem since formation occurs over a period of several hours, or in some cases days, as a result of reactions among precursor pollutants emitted over broad geographical areas. Consequently, less spatial resolution is generally required for volatile organic emissions than is necessary for other pollutants.

The second reason for compiling volatile organic emission inventories on a county basis is because of data availability. The county represents the smallest basic jurisdiction for which various records are typically kept that are appropriate for use in developing area source emission estimates. Thus, because it provides sufficient resolution for the less data intensive source/receptor relationships, and because of the convenience it affords the agency, the county is the optimum jurisdictional unit for compiling inventories to be used in developing an ozone control strategy. Countywide emissions can be summed to compile total emissions for an entire inventory area.

2.2.6 BASE YEAR SELECTION

Selecting the appropriate base year for the emission inventory is a straight forward task. The selection of the base year may depend on the years for which the agency has good air quality data, if the agency is attempting to relate air quality and emissions. However, in most control strategy inventories, the inventory base year will be determined by legal requirements, such as those set forth by EPA for SIP inventories. In any case, the base year should be determined before initiating data collection.

2.2.7 TEMPORAL RESOLUTION

Because simpler source/receptor models are not particularly sensitive to small scale temporal variations in emissions, the VOC inventories used in these models do not need to be temporally resolved to the extent necessary for the more complex photochemical models. Thus, inventories of annual emissions will generally suffice. Annual emissions data have historically been collected by most agencies for various reasons, mainly because annual activity levels are most readily available for certain sources.

In some cases, the agency may find it worthwhile to consider adjusting the annual emission estimates to more accurately reflect VOC emission rates during the ozone season. The major categories whose VOC emissions may be significantly different during the ozone season are mobile sources and petroleum product storage and handling operations. Of course, any source whose activity is known to vary seasonally will have varying emission rates. Seasonal adjustment of VOC emissions is discussed in Chapter 6.

If, for some reason, an inventory of daily emissions has been compiled, such an inventory is also suitable for use in a less data intensive source/receptor model such as EKMA. This is because in such models, the *relative* emission contribution from of each source is used to define control measures rather than the absolute quantity of emissions from each source. As long as the relative importance of each source is roughly the same, annual, seasonal or daily inventories may all be used with the less data intensive models.

2.2.8 POINT/AREA SOURCE DISTINCTIONS

A major distinction typically made in inventories is between point and area sources. Point sources are those facilities/plants/activities for which individual source records are maintained in the inventory. Under ideal circumstances, all sources would be considered point sources. In practical applications, only sources that emit (or have the potential to emit) more than some specified cutoff level of VOC are considered point sources. Depending on the needs of and resources available to the agency, this cutoff level will vary. Area sources, in contrast, are those activities for which aggregated source and emission information is maintained for entire source categories rather than for each source therein. Sources that are not treated as point sources must be included as area sources. The cutoff level distinction is especially important in the VOC inventory because there are so many more small sources of VOC than of most other pollutants.

If too high a cutoff level is chosen, many facilities will not be considered individually as point sources, and if care is not taken, emissions from these sources may not be included in the inventory at all. Techniques are available for "scaling up" the inventory to account for missing sources (see Chapter 6.4). However, such procedures are invariably less accurate than point source methods.

If too low a cutoff level is chosen, the result will be a significant increase (1) in the number of plant contacts of various sorts that must be made and (2) in the size of the point source file that must be maintained. While a low cutoff level may increase the accuracy of the inventory, the tradeoff is that many more resources are needed to compile and maintain the inventory.

A commonly recommended upper limit on the VOC point source cutoff level is 100 tons/year. If resources allow, a lower cutoff level is encouraged. A recent study in several urban areas has shown the existence of many VOC sources emitting less than 25 tons per year.[7] Moreover, many of these sources are in categories for which no reliable area source inventory procedures currently exist. Because of this, some agencies have opted to define cutoff levels below 5 tons per year in order to directly cover a larger percentage of VOC emissions in a point source inventory.

Deciding the point/area source cutoff level should be done carefully. For this reason, the reader is referred to the additional discussion on the point/area source cutoffs in Chapter 3.0.

2.2.9 DATA COLLECTION METHODS

Several methods are presented in this volume for collecting data for point and area sources of VOC emissions. However, the inventorying agency must decide which procedures to use in an VOC inventory effort. Point source methods include mail surveys, plant inspections, use of agency permit and compliance files, and source listings. Area source methods include modified point source methods, local activity level surveys, apportioning of state and national data, per capita emission factors, as well as emissions-per-employee factors.

To a certain extent, determining which data collection methods to employ will occur during the data collection, as the agency receives feedback on the success of data collection. However, the agency should, whenever possible, determine in the planning phase what methods will be used in data collection. Determining in advance which methods to use will allow time to obtain necessary reference and support materials and will help better allocate work hours to the individual data collection tasks as well.

The data collection methods and considerations for their use are discussed in greater depth in Chapters 3 and 4. The reader should refer to these chapters prior to selecting point and area source collection procedures for a VOC emission inventory.

2.2.10 EXCLUSION OF NONREACTIVE COMPOUNDS AND CONSIDERATION OF SPECIES INFORMATION

While most volatile organic compounds ultimately engage in photochemical reactions, some are considered nonreactive under atmospheric conditions. Therefore, controls on the emissions of these nonreactive compounds do not contribute to the attainment and maintenance of the national ambient air quality standard for ozone. These nonreactive compounds are listed below:

Methane
Ethane
1, 1, 1-Trichloroethane (methyl chloroform)
Methylene chloride
Trichlorofluoromethane (CFC 11)
Dichlorodifluoromethane (CFC 12)
Chlorodifluoromethane (CFC 22)
Trifluoromethane (FC 23)
Trichlorotrifluoroethane (CFC 113)
Dichlorotetrafluoroethane (CFC 114)
Chloropentafluoroethane (CFC 115)

These compounds should be excluded from emission inventories used for ozone control strategy purposes. The reader is directed to References 8 through 10 for more detailed information on the subject. Because this list may change as additional information becomes available, the inventory agency should remain aware of EPA policy on reactivity considerations.

Most of the nonreactive volatile organic compounds that should be excluded are halogenated organics that find principal applications as cleaners for metals and fabrics, as refrigerants, and as aerosol propellants. Hence, major emitting sources of many of these nonreactive compounds can be readily identified because the sources should be able to specify which solvents are being used in their operations. To this end, solvent use information is generally asked for on most questionnaires, and should be solicited in any other types of plant contacts that are made.

All combustion sources will emit methane and lesser amounts of ethane. Most emission sources will not be able to tell the agency what fraction of their VOC emissions are comprised of these nonreactive compounds. Reference 11 should be consulted for information on species compositions of various VOC emitting sources. Highway vehicles represent the most important combustion source emitting significant quantities of methane. Available EPA emission factors allow the user to exclude methane from highway vehicle emissions.[12]

EKMA and other less data intensive source/receptor models do not require information on individual organic species or reactivity classifications which are required by more detailed photochemical simulation models. Hence, the agency need not develop and maintain data on individual organic compounds in the basic inventory for the less data intensive models. Instead, to the extent feasible, the agency need only identify that fraction of emissions from each source comprised of nonreactive VOC and exclude it from the VOC emission total.

Even though species data are not needed in the basic inventory, the agency may find it worthwhile in some instances to collect this information when plant contacts and surveys are made during the basic inventory compilation effort. If an agency anticipates using a photochemical model, species data will become necessary. Moreover, data may need to be maintained on certain toxic organic materials for use in other regulatory programs. If either of these other activities is planned for the near future, it is more efficient to collect species data at the same time the other source and emissions data are collected for the basic inventory. In this regard, the agency should generally minimize the number of contacts required to any one source.

2.2.11 EMISSION PROJECTIONS

An essential element in an ozone control program is emission projections. Two types of projections are generally made: baseline and control strategy. Baseline projections are estimates of emissions in some future year that take into account the effects of growth and existing control regulations. A baseline projection is essentially an estimate of what emissions would be if no new control measures were put in place, but still taking anticipated growth into account. The baseline projection inventory is important in a control program because it serves as a reference point to determine if sufficient precursor pollutant reduction is being achieved in order to meet the ambient ozone standard. The baseline inventory can serve as an accurate reference point only if expected growth is included.

In contrast, control strategy projections are estimates of emissions in some future year, considering additional control measures. Control strategy projections should be made for the same projection years as the baseline projection inventories. This enables the agency to directly compare the relative effectiveness of each strategy as well as to determine which strategy provides the necessary control of ozone precursor emissions as indicated by the source/receptor relationship.

Two fundamentally different approaches can be used to make projections. Simple but somewhat crude projections can be made by multiplying base year summary emission estimates by general growth factors. Typically, such growth factors are surrogate indicators of activity level growth, such as industrial output, that have been adjusted to reflect some average measure of control reduction for each source category.

The alternative to the above approach is to make detailed projections for each point source. In such a detailed approach, information on anticipated expansion, process changes, and control measures is collected from each source, at the same time and in the same manner as the base year source and emissions data are collected. As a result of this approach, an entire inventory file is created for the projection year, rather than just a summary listing. This second approach, theoretically, results in more accurate projections because growth to capacity, new growth, and individual control measures can all be taken directly into account. Because of increased accuracy, the agency should generally consider making projections at the greatest level of detail possible, within given resource constraints. If the agency anticipates building on the basic inventory at some later date in order to run a photochemical model, detailed projections are needed to provide the temporal and spatial resolution necessary in such models. Emission projections are discussed in Chapter 6.

When making projections, the agency should check that consistent methodologies are used for each source category in both the base year and projection year inventories. If different procedures are used for estimating emissions, the agency cannot be sure if changes in emissions are due to its proposed control program or simply due to methodological differences. For example, if local dry cleaning solvent consumption is determined from plant questionnaires in the base year, projection year solvent consumption should not be estimated by apportioning projected nationwide solvent use to the local level.

Another important point to keep in mind during the planning stages is that the structure of the inventory determines how readily the impact of various control strategies can be estimated. For example, if a certain control measure is to be imposed on "perc" dry cleaning plants, the effect of that control is more readily simulated in a projection year inventory if emission totals for perc plants are maintained distinct from emissions from plants using petroleum or fluorocarbon solvents. Thus, the agency should anticipate what control measures are likely candidates for evaluation and should structure the source categories, data elements, and reporting capabilities accordingly, so these measures can be easily reflected in the projection inventory. Table 2.2-1 and Appendix B illustrate a format which includes most categories for which control measures have been or will be developed.

2.2.12 STATUS OF EXISTING INVENTORY

A major inventory design consideration, especially if the agency is faced with limited resources, is whether or not an existing inventory can be used as is, or selectively modified, to meet the current needs of the ozone control program. No specific guidance can be offered here, since existing inventories will obviously differ, as will the current needs of each agency. At a minimum, the existing inventory should be examined to see if the appropriate sources have been included and that the emissions data therein are reasonably representative of current conditions. The point source cutoff level for VOC emissions should be compared with current requirements. If, for some reason, the existing inventory cannot meet current needs, and cannot readily be updated or modified, it should not be discarded as totally useless. Previous inventories can at least serve as a starting point for the development of a mailing list for questionnaire distribution. The agency must be careful, however, not to rely on an existing inventory to the degree that important VOC sources or source categories are excluded. These sources may either have been (1) erroneously omitted when the original inventory was prepared or (2) omitted because VOC sources were never required to obtain permits. In the latter, many inventories have historically been compiled for particulate (TSP) and SO_x with little emphasis on sources exclusively emitting VOC. Any backup information kept on the existing inventory can also be helpful, such as the response time required for questionnaires, etc. Likewise, any specific emission factors, per capita factors, or other rules of thumb resulting from a previous inventory may still be applicable in a current effort.

2.2.13 CORRESPONDING NITROGEN OXIDES (NO_x) INVENTORY

Nitrogen oxides, along with volatile organic compounds, are precursor emissions that react to form photochemical oxidant. Consequently, a NO_x emission inventory is important in an ozone control program as well as in a VOC inventory. The EKMA model estimates of both VOC and NO_x are directly used to generate the city-specific ozone isopleths.^{5}

NO_x emissions are generally easier to inventory than VOC because most originate from combustion sources. Mobile sources and boilers typically account for the bulk of NO_x emissions in most urban areas. Other combustion sources of NO_x include internal combustion engines, incinerators, industrial sources using in-process fuels, and various open burning operations. In general, the procedures presented in this volume will adequately cover all of these sources of NO_x. Care should be taken that those few noncombustion sources emitting NO_x, but not VOC, are included in the inventory. Nitric acid, adipic acid, and nitrocellulose production, as well as explosives manufacturing, are examples of such source categories. Construction of a list of all sources of NO_x within the inventory area will aid in identifying these noncombustion sources.

2.2.14 DATA HANDLING

The agency conducting an emission inventory should be aware that data handling and retrieval can be done by computer or manually. Combinations of these two basic approaches are also possible. The selection of one approach over the other will depend on several factors:

- availability of a computer
- size of the inventory data base
- complexity of the emission calculations
- number of calculations to be made
- variety of tabular summaries to be generated
- availability of clerical and data handling personnel
- time constraints

The computer approach becomes significantly more cost effective as the data base, the variety of tabular summaries, or the number of iterative tasks increases. In these cases, the computer approach generally requires less time and has the added advantage of forcing organization, consistency, and accuracy.

Some of the activities which can be performed efficiently and rapidly by computer include:

- printing mailing lists and labels
- maintaining status reports and logs
- calculating and summarizing emissions
- storing source, emissions, and other data
- sorting and selective accessing of data
- generating output reports

Therefore, during the planning stages, an agency should anticipate the volume and types of data handling needed in the inventory effort, and should weigh relative advantages of manual and computerized systems. In general, if an agency must deal with large amounts of data, a computerized inventory data handling system allows the agency to spend more time gathering and analyzing the inventory data as opposed to merely manipulating it. In this sense, the computerized approach is superior in large areas having a diversity of sources comprising a complex inventory.

To facilitate the reporting of the local inventory data to EPA, consideration should be given to using either of EPA's inventory data handling systems (NEDS or EIS/P&R) or to developing a system that is compatible. One particular advantage of this is that numerous summary routines and various computer modeling programs have been designed to operate on the NEDS and EIS data bases, including a wide variety of retrieval programs that enable the user to provide summaries of source, control device, and emissions data for a number of geographical areas down to the county level. NEDS and EIS are described briefly in Appendix F, and in more detail in References 13 through 17.

If the agency anticipates use of a photochemical dispersion model at some future date, it is imperative that a computerized data handling system be utilized. The added complexity involved in developing spatially and temporally resolved estimates of several VOC classes from the basic inventory simply represents too much work to complete manually. Generally any area large enough to warrant the use of a photochemical model will have a computerized data handling system in place to handle the important inventory functions. Data handling requirements for inventories used in photochemical models are discussed in Volume II.

Quality assurance is another consideration for selecting a computer system for data handling. A computer can conduct emission calculation and editorial checks much faster than doing them manually. Thus, how an agency intends to conduct quality assurance tests on the emissions inventory should be considered when deciding on manual or computer handled data systems.

2.2.15 QUALITY ASSURANCE

Quality assurance is important in achieving user confidence in an emission inventory. A quality assured inventory will result in better assessment of emission inputs on air quality. Also, lower program costs may be realized because inventory updates and revisions will not be as extensive as would be expected without a quality assurance program.

A quality assurance program applied to emission inventory procedures would have three general types of procedures. Standard operating procedures would include organization planning, personnel training, project planning, and the development of step-by-step procedures for technical tasks. Techniques for finding and correcting inconsistencies and errors would include identification of potential error sources, evaluation of the impact of these sources, location of checkpoints for optimal problem detection, and a provision for timely response when problems occur. The determination of product quality and reliability, in the context of an emission inventory, is the same as data quality assessment. These procedures include a periodic review of the entire inventory process, the development of standards against which to test the accuracy and precision of results, and a system evaluation to maintain optimal resource efficiency.

With the exception of computerized data processing, the emission inventory process focuses on human factors. As a consequence, quality assurance for emission inventory applications might be weighted more heavily toward procedures analysis, the first two of the above procedures. Standard operating procedures can be outlined as the inventory effort is planned. Identifying and correcting inconsistenies and errors in the inventory can also be anticipated in the planning phase. The following potential error sources can be found in most emission inventories.

° Missing facilities or sources - Permit and inventory systems out of phase; errors in estimating potential emissions; lost paperwork; problems with computer file updates.

° Duplicate facilities or sources - Name changes through corporate acquistions; use of multiple data sources with different source numbering schemes.

- Missing operating or technical data - Ambiguous data request forms; intentional deletion by facility staff; inadequate followup procedures; no preliminary indication of inventory size; or overall inadequate project control.

- Erroneous technical data - Misinterpretation of data request instructions; assumed units, faulty conversions, etc.; intentional misrepresentation by the facility; poor handwriting.

- Improper facility location data - Recording coordinates of facility headquarters instead of the operating facility; inability of technicians to read maps; failure to observe inventory area boundaries.

- Inconsistent area source categories or point source sizes - Failure to designate inventory cutoffs.

- Inaccurate or outdated data - Mixed use of primary and secondary data without a standard policy.

- Errors in calculations - Transposition of digits; decimal errors; entering wrong numbers on a calculator; misinterpreting emission factor applications.

- Errors in emission estimates - Imprecise emission factors; applying the wrong emission factor; errors in throughput estimates; improper interpretation of combined sources; errors in unit conversions; faulty assumptions about control device efficiency; failure to exclude nonreactive emissions.

- Reported emissions wrong by orders of magnitude - Recording the wrong identification code for subsequent computer emission calculations; ignoring implied decimals on computer coding sheets; transposition errors; data coding field adjustment.

Product quality is more difficult to assess in an emission inventory than in a quality assurance application involving physical instruments such as pollutant analyzers, monitoring sites, and calibration equipment. If a computer data handling system is available, a computer program can perform checks on point source data records. A program could check for implausible entries, missing data, and conformity of calculated results with known data relationships. Manual spot checks on the point source records can be performed when computers are not available.

Principles of quality assurance can be applied in planning, data collection, calculations, and reporting of a VOC emission inventory. Quality assurance can be made quite effective by anticipating the measures needed in each of these inventory functions. To promote effective quality assurance, the inventory planner should consider the principles listed below prior to initiating inventory tasks.[18]

Planning:

- Plan to allocate resources for maximum quality assurance.
- Plan to account for significant VOC emission sources.

- Prepare a checklist of sources to be evaluated.
- Use staff experienced in data collection and analysis.
- Plan for routine checking of calculations.
- Plan checking of data file entries.
- Prepare data checking programs (when using a computer for data handling).
- Maintain a separate quality assurance staff.
- Plan audit procedures.

Data collection and analysis:

- Use redundant identification of major sources (quality assurance staff should prepare an independent source list).
- Check questionnaire design.
- Check questionnaire responses.
- Check data collected.
- Check emissions estimation methods.
- Check calculated results.
- Verify adherence to quality assurance procedures.

Data handling:

- Check data file entries.
- Check individual data entries (missing emissions, SIC codes, addresses, etc.)
- Assign agency estimates for missing data.
- Check for data correctness.
- Review tabulated data for quality.

Data reporting:

- Check the aggregation of emissions.
- Compare results with those of other inventories.
- Check disaggregation of emissions (if allocated to subcounty areas).

The above is intended as a primer to acquaint the user with the concepts and principles of quality assurance. Before planning a quality assurance program, the reader should obtain additional information on these concepts and principles. Such information on emission inventory quality assurance can be found in References 18 through 20 or can be obtained through an EPA Regional Office.

2.2.16 DOCUMENTATION

Documentation is an integral part of a VOC emission inventory. By documenting an inventory's supporting materials, errors in procedures, calculations or assumptions are detected easier. In addition, a well documented inventory will be a defensible data base which is valuable in enforcement actions, source impact assessments, and development of emission control strategies as well.

While documentation requirements may evolve during the data collection, calculation, and reporting steps of the emission inventory, these requirements should be anticipated in the planning phase. Planning what level of documentation required will (1) ensure that important supporting information is properly developed and maintained, (2) allow extraneous information to be identified and disposed of, thereby reducing the paperwork burden, (3) help determine hard copy file and computer data storage requirements, and (4) aid in identifying aspects of the inventory on which to concentrate quality assurance efforts. Thus, planning documentation for the emissions inventory will benefit both the emissions inventory effort and the agency.

2.2.17 ANTICIPATED USE OF A PHOTOCHEMICAL DISPERSION MODEL

The basic inventory compiled for use with a less data intensive source/receptor model can serve as a good starting point for creating a photochemical modeling inventory. If the agency expects to use a photochemical dispersion model at some subsequent date without redoing the existing data base, certain considerations should be made in the basic inventory effort from the outset.

An example of such a consideration is given in Section 2.2.14. Because of the extensive data handling activities required in producing a photochemical modeling inventory, a computerized inventory file should be developed from which a "modeler's tape" can be created. (The modeler's tape is the final inventory product that is actually input to the photochemical model.)

The amount of source data that should be collected during the basic inventory update will be increased if the agency anticipates the use of a photochemical dispersion model. If a photochemical model is to be used, sufficient additional information should be collected to allow the agency to develop the necessary spatial and temporal resolution and VOC classifications needed by these models. Specifically, (1) detailed locational coordinates and stack data should be obtained for each point source (this information is already maintained in many basic inventory systems), (2) socioeconomic data should be obtained for subsequent area source apportioning, (3) daily and hourly operating patterns are needed for the ozone season, and (4) VOC species profiles should be defined for each emissions category. In order to minimize the number of contacts made to any particular source, the agency should obtain as much of this additional information as possible during the contacts made to update the basic inventory. Volume II further discusses the data requirements for photochemical modeling inventories.[1]

A third consideration influences the structure of the basic inventory. Because VOC emissions must be apportioned to various classes in the photochemical modeling inventory, the basic inventory should be structured to facilitate this step. To a large extent, this can be effected by a judicious choice of source categories. As an example, drycleaning plants using perchloroethylene should be distinguished from those using petroleum solvent because each of these solvents needs to be apportioned differently into VOC classes. As another example, evaporative and exhaust emissions from gasoline powered vehicles should be distinguished because these emissions are comprised of such different organic species. In general, if separate emission totals can be maintained for the important solvents used in an area, and the exhaust/evaporative distinction is maintained for gasoline powered vehicles, the basic inventory can readily be used for generating the VOC classifications needed by photochemical models. Maintaining separate totals for various solvent types is useful in the basic inventory as well, because the agency can more readily exclude those particular compounds (discussed in Section 2.2.10) that do not participate in ozone formation.

Volume II[1] of this series should be studied during the planning stages of the basic inventory process, if the agency may run a photochemical model in future modeling analyses.

2.2.18 PLANNING REVIEW

By the completion of the planning phase of the inventory effort, and prior to initiating the data collection phase, the agency should have addressed the items listed below.

- The end use(s) of the inventory are established.
- Source categories have been defined which are compatible with available source and emission information, and are of sufficient detail to faciliate control strategy projections excluding nonreactive compounds.
- Manpower and budget allocations have been made.
- The geographical inventory area has been identified and the necessary spatial allocation determined.
- The inventory base year has been selected.
- Decisions have been made on whether to adjust emissions seasonally, which sources will be seasonally variable, and whether emissions will be compiled annually or daily.
- The point source cutoff has been defined, the relative quantity of sources below the emissions cutoff level has been estimated, and scaleup and area source procedures selected.
- How point and area source data can best be collected has been determined.
- Procedures for identifying nonreactive emissions have been selected.

- The agency has decided on how emissions will be projected and the projection period, including end year and intermediate years, has been designated.
- The role of existing inventory data has been determined and any previously omitted important VOC sources have been identified.
- All sources of NO_x emissions are identified, including noncombustion industrial processes which do not emit VOC.
- An inventory data handling system has been selected.
- Quality assurance procedures have been selected.
- The agency's future use of a photochemical dispersion model has been considered and the appropriate adjustments in inventory plans have been made, including review of Volume II, if necessary.

References for Chapter 2.0

1. Procedures for the Preparation of Emission Inventories for Volatile Organic Compounds, Volume II, EPA-450/4-79-018, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

2. Compilation of Air Pollutant Emission Factors, Third Edition and Subsequent Supplements, AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1977.

3. James H. Southerland, "Emission Inventories: A Perspective," presented at the 71st Annual meeting of the Air Pollution Control Association, Houston, TX, June 25-30, 1978.

4. Thomas Donaldson and Michael Senew, "Estimating the Cost of State Emission Inventory Activities," presented at the 73rd Annual Meeting of the Air Pollution Control Association, Montreal, Canada, June 22-28, 1980.

5. Uses, Limitations and Technical Basis of Procedures for Quantifying Relationships between Photochemical Oxidants and Precursors, EPA-450/2-77-021a, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1977.

6. Federal Air Quality Control Regions, AP-102, U.S. Environmental Protection Agency, Rockville, MD, January 1972.

7. Mahesh C. Shah and Frank C. Sherman, "A Methodology for Estimating VOC Emissions from Industrial Sources," presented at the 71st Annual Meeting, American Institute of Chemical Engineers, Miami Beach, FL, November 1978.

8. Recommended Policy on the Control of Volatile Organic Compounds, 42 FR 35314, July 8, 1977.

9. Clarification of Agency Policy Concerning Ozone SIP Revisions and Solvent Reactivities, 44 FR 32042, June 4, 1979, and 45 FR 32424, May 16, 1980.

10. Clarification of Agency Policy Concerning Ozone SIP Revisions and Solvent Reactivities, 45 FR 48941 July 22, 1980.

11. Volatile Organic Compound Species Data Manual, Second Edition, EPA-450/4-80-015, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1980.

12. User's Guide to MOBILE1, EPA-400/9-78-007, U.S. Environmental Protection Agency, Washington, DC, August 1978.

13. AEROS Manual Series, Volume I: AEROS Overview, EPA-450/2-76-001 U.S. Environmental Protection Agency, Research Triangle Park, NC, February 1976.

14. AEROS Manual Series, Volume II: AEROS Users Manual, EPA-450/2-76-029, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1976.

15. AEROS Manual Series, Volume III: Summary and Retrieval Second Edition, EPA-450/2-76-009a, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1977.

16. The Emissions Inventory System/Area Source User's Guide, EPA-450/4-80-009, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1980.

17. The Emissions Inventory System/Point Source User's Guide, EPA-450/4-80-010, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1980.

18. Rich Bradley, Joan Stredler, Hal Taback, "Improving Emission Inventory Quality - A QA/QC Approach," presented at the 73rd Annual Meeting of the Air Pollution Control Association, Montreal, Canada, June 22-27, 1980.

19. Development of an Emission Inventory Quality Assurance Program, EPA-450/4-79-006, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1978.

20. I. M. Goklany, "Emission Inventory Errors for Point Sources and Some Quality Assurance Aspects," Journal of the Air Pollution Control Association, 30(4): 362-5, April 1980.

3.0 POINT SOURCE DATA COLLECTION

As discussed in Chapter 2, point sources are those facilities/plants/activities for which individual records are maintained in the inventory. Two major decisions must be made during the planning stages that will have a major impact on the scope of the point source inventory: (1) what cutoff level will be chosen to distinguish point from area sources and (2) what procedures will be employed to collect data on each facility.

The choice of a point source cutoff level will not only determine how many point sources will be contained in the inventory, but also will impact on the kinds of sources included. As a rule, the lower this cutoff level is, (1) the greater the cost of the inventory, (2) the more confidence users will have in the source and emissions data, and (3) the more applications that can be made of the inventory. At a minimum, all facilities exceeding 100 tons of VOC per year should be inventoried as point sources and each process emission point should be identified. If possible, a point source cutoff level of less than 100 tons per year should be selected to avoid handling the myriad of medium size VOC emitters found in most urban areas as area sources. In some cases, the agency may decide to pursue lower cutoff levels or to simply include all of a certain type of source in the point source inventory, regardless of size. This may be desirable, for example, if all sources in a certain category are subject to control regulations such as RACT.

Prior to the point source data collection effort, all planning considerations discussed in Chapter 2 should also be taken into account. At a minimum, every source category shown in Table 2.2-1 and the process emission points shown in Appendix B should be considered for inclusion, with an emphasis on those RACT categories for which controls are anticipated in the ozone control program. As an aid to the agency in this regard, Appendix C contains summary information on each source category for which EPA has published a Control Techniques Guideline (CTG) document. This information can help the agency decide whether a given source category (or some segment thereof) should be included in the point source inventory; what processes need to be identified as distinct emitting points; what kinds of controls represent reasonably available technology; and what presumed reductions are related to the implementation of these controls. The CTG documents cited in Appendix C should be studied by the inventory agency, as they contain a great deal of detailed source, emissions, and control device information on the major sources that should be encompassed in a VOC inventory.

The second major decision regards what particular procedures should be used to collect data for each point source category. All point source procedures have two common elements: (1) they all involve some sort of direct plant contact and (2) an individual point source record is generated as a result of the plant contact that is maintained as a separate entry in a point source file. Plant contacts of various sorts can be made. The two most common types of plant contact are the mail survey and direct plant inspections. A type of indirect plant contact also commonly employed is the use of permit applications or compliance files. These three techniques for collecting point source data are discussed in this chapter.

3.1 QUESTIONNAIRES (MAIL SURVEY APPROACH)

A common technique used by air pollution control agencies for gathering point source emission inventory data is the mail survey. The primary purpose of a mail survey is to obtain source and emission data by means of a questionnaire mailed to each facility. In order to conduct this type of data gathering operation efficiently, the facilities to be surveyed must be identified; mailing lists must be prepared; questionnaires must be designed, assembled and mailed; data handling procedures must be prepared and organized; and response receiving systems must be established. The following text discusses the details of each of these general operations.

3.1.1 PREPARING THE MAILING LIST

A necessary step in the mail survey is the preparation of a mailing list that tabulates the name, address, and general process category of each facility to be surveyed. The basic function of the mailing list is to identify those sources to which questionnaires will be sent. The mailing list may also serve other functions. For example, the general process category information obtained from the mailing list can assist the agency in the determination of those categories for which questionnaires must be designed. In addition, the size of the resulting mailing list gives the agency an indication of how many of what kinds of sources can effectively be considered in the point source inventory within resource limitations. In this regard, the mailing list can be used to help the agency determine if the resources allocated for the compilation effort will be sufficient. Frequently, more sources are identified than are believed to exist during the initial planning stages.

The mailing list is compiled from a variety of information sources, including the following:

- Existing inventories - An existing inventory is a good starting point if it is not over several years old or if it has been frequently updated and will documented. Caution is in order since many inventories are compiled for pollutants other than VOC. Hence certain sources, such as solvent users emitting only VOC, may not be well represented in existing inventories. Moreover, some sources of VOC that are considered collectively as area sources within the existing inventory may, instead, need to be treated as point sources in the updated VOC inventory.

- Other air pollution control agency files - Compliance, enforcement, permit application, or other air pollution control agency files may provide valuable information on the location and types of sources that exist in the area of concern. These files can also be utilized later to cross check certain information supplied on questionnaires.

- Other government agency files - Files maintained by labor departments and tax departments frequently aid in the preparation of the mailing list. Such files would include various state industrial directories wherein companies are listed alphabetically by SIC and county. The information available in these files will vary from state to state. Thus, it is advisable to contact the appropriate personnel within these agencies to become familiar with what listings are available.

° EPA/CTG source listings - EPA's Division of Stationary Source Enforcement has developed point source listings for several source categories for which CTG documents have been published.[1-8] The listings provide a company name, address, and in some cases, a phone number for each source. These listings are available through EPA Regional offices upon request by a State or local air pollution control program. In addition, EPA is developing a more detailed RACT compendium for VOC sources. Included in the compendium are additional source categories for which EPA intends to publish CTG documents (see Appendix C). As the compendium becomes available, it will be also made available through EPA Regional offices.

° Other local information sources - The following local information sources can be consulted, where available:

- Local industrial directories - A local industrial development authority may provide a list of the latest sources which operate in the inventory area.

- Yellow Pages - The local telephone directory will have names, addresses and phone numbers of many industrial/commercial VOC sources. Caution is advised in that phone directory areas often do not correspond to county or community boundaries.

- Manufacturers and suppliers - Contact firms that make or supply equipment and materials used in industries emitting VOCs, such as solvents storage tanks, gasoline pumps, or VOC emissions control equipment. Some firms have good contacts within industry and may be able to provide information concerning the existence and location of VOC sources.

° National publications - The national publications listed below can be used when available. However, the information contained in them may be older and less accurate than local primary references.

- Dun and Bradstreet, Million Dollar Directory[9] - Companies with sales over $1,000,000 a year are compiled by SIC and county.

- Dun and Bradstreet, Middle Market Directory[10] - Companies with sales between $50,000 and $1,000,000 a year are compiled by SIC and county.

- Dun and Bradstreet - Industrial Directory[11]

- National Business Lists[12] - Companies are listed by SIC and county with information on financial strength and number of employees.

- Trade and professional society publications[13,14] - Names and addresses of members are listed along with their type of business.

When compiling the final mailing list, special attention should be given to the Standard Industrial Classification (SIC) code associated with each source, when it is known. SICs are a series of codes devised by the U.S. Office of Management and Budget to classify establishments according to to the type of economic activity in which they are engaged.[15] If an SIC corresponds to one given in Table 3.1-1, an increased likelihood exists that the source is an important source of VOC emissions.

Once these various sources have been consulted and a mailing list drafted, the list should be ordered to facilitate the necessary mailing and followup activities. A logical order in which to list companies is by city or county, then by SIC, and finally, alphabetically. Ordering the list in this manner will increase the efficiency of all subsequent data handling tasks. Visual spot checking of the resulting listing will eliminate many of the duplications.

3.1.2 LIMITING THE SIZE OF THE MAIL SURVEY

If more sources are identified on the mailing list than can be handled within available resources, the agency should screen the mailing list in some manner to reduce the number of facilities to be sent questionnaires. This can be done in a number of ways. One way is to limit the mailout to only those sources believed to emit annually more than a certain quantity of VOC. Appendix C contains estimates of typical VOC emissions associated with industrial processes within many important source categories. These typical emission estimates can be used to determine if certain operations should be handled as point or area sources. For example, in Table C-21 of Appendix C, typical coin operated ("coin-op") and commercial dry cleaning plants are estimated to emit only 1.6 and 3.6 tons per year, respectively. Hence, if the agency's point source cutoff level is 25 tons per year, it may decide to treat all coin-op and commercial plants as area sources, and not send them questionnaires.

In many instances, the number of employees in a company will be known, and an estimate of the potential magnitude of emissions can be made by applying emission-per-employee factors, such as are shown in Table 3.1-1. The range of emissions in Table 3.1-1 for some two-digit Standard Industrial Classification (SIC) categories suggests that this technique may yield widely varying estimates of a source's annual emissions. If the agency has sufficient budgeted resources, the higher emission-per-employee factors can be used. This will cause an initial overestimate of each point source's emissions, placing more sources above the determined cutoff level. As a result, questionnaires will be sent to more sources.

Another method for reducing the mailing list to a manageable size is to make telephone contacts to selected sources within each major category. If there is any doubt about particular source types being potentially large emitters, brief contacts with plant managers or other appropriate employees at a few representative facilities may indicate if VOC emitting processes are common. Moreover, by obtaining activity levels or the number of employees, the agency can estimate what facilities within the source category will be of sufficient size to warrant receiving a questionnaire.

Table 3.1-1. Standard Industrial Classifications (SICs) Associated With VOC Emissions; Emission-Per-Employee Ranges[8,9]

General 2-Digit SIC Categories		Specific 4-Digit SIC Categories	Emission-Per-Employee Ranges (tons/employee/yr)
20	Food	Alcoholic beverages (2085)	0.075
21	Tobacco	Not surveyed	-
22	Textiles	Coating (2295), Non-wovens (2297), Dyeing (2231)	0.536-0.89
23	Apparel	Not surveyed	-
24	Lumber & wood	Finished product (2435), (2492)	0.024-0.07
25	Furniture & fixtures	SIC: (2511), (2514), (2521), (2522), (2542)	0.08-0.24
26	Paper	Bags, box (2643), (2651), (2653), Coated papers (2641)	1.0-1.25
27	Printing	Newspaper publishing (2711), Comm. printing (2751), (2754)	0.08-0.05
28	Chemicals	Organic chemical mfg. (2821), (2823), 2861), Chemical coating (2851). Specialty chemical (2842), Carbon black (2895)	0.32-0.357
29	Petroleum	All companies	0.11-2.12
30	Rubber, Plastic	Footwear (3021), Plastics (3041), (3069)	0.16-0.256
31	Leather	Mfg. shoes (3149), Bags (3161), Personal goods (3172), Leather refinishing (3111)	0.13
32	Stone, clay, etc.	Glass products (3221)	0.03-0.092
33	Primary metal	Treating (3398), Tubing (3357)	0.10-0.267
34	Fab. metal	Screws (3451-2), Metal stampings (3469), Plating (3471), Tool mfg. (3423), (3429)	0.19-0.281
35	Machinery	Industrial machines	0.03-0.048
36	Elect. Machinery	Devices (3643), Semicond. (3674)	0.04-0.07
37	Transpt. equip.	Boats (3732), Truck bodies (3711), 13, 14, 15)	0.11-0.855
38	Instruments	Optical frames (3832) Precision instruments	0.04-0.199
39	Misc. Mfg.	Jewelry (3914-15), Toys (3944), Writing instr. (3951,53)	0.07-0.59
5171	Bulk terminals	All surveyed	-
7216	Dry cleaning	All surveyed	-

3.1.3 DESIGNING THE QUESTIONNAIRES

After the mailing list has been prepared, a questionnaire must be prepared for each facility to be contacted. This can be done either by preparing industry-specific questionnaires for each source category or by preparing "catchall" questionnaires that encompass many source categories. If sufficient resources are available, industry specific questionnaires are advantageous for certain sources. Such questionnaires will generally be shorter, because questions not applicable to the particular industry need not be included. In addition, industry-specific terminology can be used that is familiar to those working in a particular industry but which may not be understood by others. This can enhance communication and reduce confusion. For these reasons, inventory accuracy is increased when industry-specific questionnaires are used. On the other hand, this approach has several disadvantages. One disadvantage is that the design of many industry-specific questionnaires requires significant resources. Second, all the returned questionnaires cannot be processed in the same way because of the variations in format that will exist from questionnaire to questionnaire. Third, incorrect industry-specific questionnaires may be inadvertantly sent to some sources because of limited prior knowledge of the operations at these sources.

Generally, if the mailing list is long, if the agency is unfamiliar with many of the sources on the list, or if agency resources are limited, the use of general questionnaires may be advisable. Oftentimes in practice, a general questionnaire is merely a collection of process-specific questionnaires sent out as one questionnaire.

Questionnaire design entails the establishment of a suitable format, the selection of appropriate questions, the wording of questions, and the development of an appropriate cover letter and instructions for filling out the questionnaire. The basic rule is to design the questionnaire for the person who will be asked to complete it. The agency should consider the fact that the person who will complete the questionnaire may not have the benefit of a technical background in air pollution, engineering, or physical sciences. Hence, questionnaires should be designed to be understood by persons without specialized technical training.

The format of the questionnaire should be as simple and as functional as possible. When data handling is to be done by computer, time will generally be saved if the questionnaire format is such that a keypunch operator can readily keypunch the information directly from each questionnaire. The questions should be well spaced for easy readability with sufficient area for complete responses. The questionnaire should be as short as possible, because most people dislike or are intimidated by lengthy questionnaires. Also, shorter questionnaires reduce postal costs. When preparing the questions, use terminology with which the recipient will be familiar. Each question should be self explanatory or accompanied by clear directions. All necessary information should be solicited on the questionnaire, thus avoiding later requests for additional data. Any additional data need for subsequent application of a photochemical model should be collected at this same time, as well. (Volume II describes these necessary additional data.)[18]

Each questionnaire sent out should be accompanied by a cover letter stating the purpose of the inventory and citing any statutes that require a response from the recipient. The letter should include a simple explanation of the ozone problem and relate VOC emissions to ozone formation. If the inventory is for an ozone nonattainment area, some discussion on the implications of the nonattainment designation might be advisable. Cooperation in filling out and returning the questionnaire should be respectfully requested. In addition, each questionnaire should be accompanied by a set of general procedures and instructions telling the recipient how the questionnaire should be filled out and by what date it should be returned to the agency. In lieu of putting a specific reply date in the cover letter, a specific number of calendar or working days to respond can be included. In this manner, delays in mailouts will not require the changing of the reply date in each letter. If a general questionnaire is sent out, the instructions should carefully explain that the questionnaire has been designed for a variety of operations and that some questions or sections of the questionnaire may not apply to a particular facility. In all cases, a contact name, telephone number, and mailing address should be supplied in case a recipient has questions. The cover letter and instruction can be combined in some cases, but this should only be done when the instructions are brief. An example cover letter and set of instructions are shown in Appendix D. A variety of additional examples are presented in Reference 19.

When determining the information to request on the questionnaire, the ultimate use of the data should always be considered. In addition to general source information, such as location, ownership, and nature of business, correct process information should also be requested. Since activity levels, including indicators of production and fuel consumption, are generally used with emission factors to estimate emissions from most sources for which source test data are not available, the appropriate activity levels must be obtained for each type of source. The type of activity levels needed to calculate emissions from point sources are available for most VOC emitters in AP-42.[20] In addition, since many of the emission factors in AP-42 represent emissions in the absence of any controls, control device information should also be obtained in order to estimate controlled emissions. Control device information is also helpful for determining potential reductions in emissions from applying various control strategies, especially for those source categories for which CTG documents have been published. Finally, any information that is needed to make corrected or adjusted emission estimates should be solicited. For example, since emissions from petroleum product storage and handling operations are dependent on a number of variables, including temperature, tank conditions, and product vapor pressure, appropriate values should be obtained for these variables that will allow the agency to apply the correction factors given in Chapter 4 of AP-42. If seasonal adjustments are considered, special emphasis should be given to variables such as activity levels, temperature and windspeed that cause seasonal variations in emissions. (Seasonal adjustment of emissions is discussed in Chapter 6.)

Other information may be solicited in the questionnaires depending on the agency's needs in its ozone control program. For example, stack data such as stack height and diameter, exhaust gas temperature and flow rates may be required for modeling purposes. Information on fuel characteristics, generally sulfur, ash, and heat contents, may also be desirable. Certain compliance information may be needed if the agency is using the inventory for enforcement purposes. Information on the nature or brand name of any solvents is particularly helpful to the agency in excluding nonreactive VOC from the emission totals. Process schematics, flowcharts, and operating logs, may be requested to be returned with the questionnaire in cases where the source is unique and/or complex. Each source should be requested to include documented emission estimates or to enclose source test results, if available.

An example cover letter/instruction sheet/questionnaire package aimed specifically at obtaining information on solvent users is shown in Appendix D. A number of the elements required in a questionnaire package are illustrated in this example. It should be noted that the questionnaire will not be applicable to all major VOC emitting sources. Additional questionnaires must be developed to cover refineries, chemical manufacturers, and other VOC sources. Various example questionnaires dealing with many of the major source categories are presented in Reference 19. Before adopting any questionnaires, the agency should carefully consider the objectives of the VOC inventory in its ozone control program, and then should determine if the data supplied in these questionnaires will meet these objectives.

Since some facilities are unique in design and operation compared to other facilities within the same source category, it is difficult to design questionnaires adequately to accommodate such differences and still be of manageable size. Thus, segments of some of the questionnaires may need to be unformatted, with the plant contact being asked to fill in whatever information he feels is required to describe the source and its emissions. As a rule, formatting is desirable to the maximum extent possible, because it helps avoid confusion both to the person filling out the questionnaire and to the agency itself. Formatting, in this context, refers to a description of what information is needed, the units in which the data should be expressed, and where on the form the requested data should be located.

While questionnaires are generally tools used for obtaining point source data, they can be used to collect certain area source data as well. For example, many questionnaire recipients emit so little that the agency will not want to maintain an individual record on them, but rather, will simply group them in with an area source category such as small dry cleaning establishments. In addition, questionnaires can be used in certain situations to directly obtain area source information. As an example, suppliers of fuels or some kinds of solvents in an area may be contacted to get the amount of fuel or solvent consumed collectively by residential and commercial customers. Frequently, area source emissions will be determined through other techniques, such as field surveys or the use of information found in special publications. Area source data collection techniques are included in Chapter 4.

3.1.4 MAILING AND TRACKING THE QUESTIONNAIRES AND LOGGING RETURNS

Once the final mailing list has been compiled and the appropriate questionnaire packages are assembled (including mailing label, cover letter, instructions, questionnaires, and self addressed stamped envelope), the agency should proceed with the mailout activities. The mailing of the questionnaires can be performed in two ways. The first method is by registered mail, which informs the agency when a questionnaire is received by the company. This does not guarantee that the company will return the form, but the rate of response will probably be somewhat greater than if the questionnaires are sent by first class mail. However, the slight increase in response may not justify the added expense of sending every company a registered letter. As a compromise, registered mail may at least be used to contact major sources.

The second method is to send the questionnaires by conventional first class mail. This method has proven to be effective, if the address includes the name of the plant manager or if "Attention: PLANT MANAGER" is printed on the outside of the envelope. This directs the envelope to the proper supervisory personnel and reduces the chances of the questionnaire package being discarded. It is highly recommended that a stamped envelope be included with each questionnaire, as it is thus more likely to be returned.

Generally, responses will start coming in within a few days after mailing. Many of the early returns may be from companies that are not sources of VOC emissions. Also, some of the questionnaires will be returned to the agency by the postal service because either the establishment is out of business or the company is no longer located at the indicated mailing address. New addresses for companies that have moved can be obtained by either looking up their addresses in the telephone book or contacting an appropriate state or local agency, such as the tax or labor departments.

A simple computer program can be helpful in the mailing and logging-in of the questionnaires. Such a program should be designed to produce a number of duplicate mailing labels for each source sent a questionnaire. One label is attached to the outside of the envelope containing the questionnaire materials. A second label is attached to the cover letter or instruction sheet of the questionnaire. This facilitates the identification of the questionnaires as they are returned, as well as name and mailing address corrections. Additional mailing labels may be used for other administrative purposes or to recontact those sources whose responses are inadequate. An example label is shown below:

0000 (SIC Code)   0000 (I.D. Code)
INDIVIDUAL's NAME (or PLANT MANAGER)
TITLE
COMPANY NAME,
STREET,
CITY, STATE, ZIP CODE

It may be helpful to print the SIC code on the upper left and an assigned identification number on the upper right of the labels. The ID number is used to keep records of all correspondence with a company. If the study area is large, a county identification number may also be included on the mailing label.

It is important to develop some sort of tracking system to determine the status of each facet of the mail survey. Such a tracking system should tell the agency: (1) which companies questionnaires are mailed to; (2) the dates the questionnaires are mailed and returned; (3) corrected name, address, and SIC information; (4) preliminary information on the nature of the source; (5) whether recontacting is necessary; and (6) the status of the followup contact effort. Tracking can be accomplished manually through the use of worksheets or through the use of a simple computer program. A computer printout of the mailing list can be formatted for use as a tracking worksheet.

As soon as the questionnaires are returned, some useful analyses can be performed. One activity that can help enhance the timely completion of the mail survey, as well as assist in estimating the amount of resources that will be subsequently needed in the inventory effort, is to classify each response in one of the five categories listed below:

P - VOC point source
A - VOC area source
N - No VOC emissions (non-source)
OOB - Out of business
R - Recontact for reclassification

In addition, the agency can begin performing emission calculations for those sources that do not supply emission estimates, and the resulting source and emissions information can begin to be loaded into the inventory files. All responses should then be filed by SIC, source category, geographic location, alphabetics or by any other criteria that enable orderly access for further analysis at some later time.

3.1.5 RECONTACTING

Sources may have to be recontacted by the agency for two basic reasons: the source may not have returned the questionnaire at all, or the response provided may not have been adequate to meet the agency's needs. If the source has received the questionnaire but has not returned it as requested, it can be recontacted by a more formal letter citing statutory reporting requirements on completing the questionnaire. When the number of sources to be recontacted is small, the information can be obtained through telephone contacts or plant visits. If the source refuses to complete the questionnaire (1) some sort of crude emission estimate can be made based on activity levels or number of employees or (2) if a statute exists requiring a response, legal action can be taken to force a response.

Recontacting activities should begin two to four weeks after the questionnaires are mailed. Telephone calls are advantageous when recontacting sources, in that direct verbal communication is involved and additional mailing costs can be avoided. Caution is urged that, when making extensive telephone contacts, all Federal, state, or other applicable clearance requirements are observed. A second followup mailing may be necessary, if a large number of sources must be recontacted. In either case, recontact should be completed 12 to 16 weeks after the first mailing.

3.2 PLANT INSPECTIONS

In addition to the mail survey, plant inspections are another technique commonly used to gather data for the point source inventory. During plant inspections, agency personnel usually examine the various processes at a particular facility and interview appropriate plant personnel. If the agency's resources permit, source testing may be conducted as a part of the plant inspection. Because plant inspections are generally much more time consuming than questionnaires, they are ususally performed only at major point sources.

Plant inspections may constitute either the initial contact an agency has with a source or, alternately, they can be used as a method of recontacting sources either to obtain additional information or to verify data that were submitted in the questionnaire. In either case, the goal of plant inspections is to gather source data not ordinarily obtainable through other means. The major advantage of the plant inspection is that it may provide more thorough and accurate information about emitters than does the questionnaire alone. In addition, errors resulting from misinterpretation of the questionnaire, or the agency's misinterpretation of the response are avoided. Finally, in cases where a process is unique and/or complex, the only realistic way for the agency to gain an adequate understanding of the emitting points and variables affecting emissions is to personally observe the plant equipment and to go over the operations and process schematics with the appropriate plant personnel. However, a plant inspection should not be used to complete a point source questionnaire at the plant site. Plant managers and engineers usually do not have immediate access to data on equipment specifications, process rates, or solvent purchases. Plant personnel need time to assemble materials necessary to complete questionnaires. For these reasons, the agency should make an appointment with the plant personnel and provide the plant manager with questionnaires prior to an inspection.

The data that are acquired in the plant inspection are basically the same as are solicited in a questionnaire. Generally, more data may be obtained than would normally be requested on the questionnaire, such as plant flow diagrams, logs of various process variables, photographs of various emission points, and control device characteristics. Naturally, if the plant has source tested processes within the facility, the test results should be obtained for use in the inventory. Any source test data supplied by a particular plant should be reviewed before they are used in the inventory, to make sure that acceptable sampling and analytical procedures were employed and that the test conditions were reasonably representative of the time period covered by the inventory.

Special plant inspection forms may be developed to help the agency conduct the plant visit. Because of the extra resources required, such forms should only be developed when many plant inspections are anticipated, when certain major sources are prevalent, and when the same kind of information will be requested during each visit. This latter condition may not hold in situations where the agency is using the plant inspection as a followup to the questionnaire.

3.3 OTHER AIR POLLUTION AGENCY FILES

During the point source data collection effort, the agency should consider using information included in its own permit and/or compliance files. Permits are typically required for construction, start up and continuing operation of an emission source. Of importance to the inventory effort is the fact that permit applications generally include enough information about a potential source to get a good idea of the nature of the source as well as to estimate the magnitude of emissions that will result from its operations. The inventory effort should make maximum practical use of information in permit files. At least, the permit application file can be used for the development of the mailing list or for determining the need for a plant inspection or telephone contact when the source comes on line.

Another type of file that may be maintained by some agencies is the compliance file. A compliance file is a record of the agency's dealing with each source on enforcement matters. For example, a compliance file might contain a list of air pollution regulations applicable to a given source, a history of contacts made with that source on enforcement matters, and an agreed upon schedule for the source to effect some sort of control measures. Because the compliance file will commonly contain basic equipment information as well as baseline emissions data, it can be a useful tool in the inventory effort. Again, at a minimum, each source in the compliance file should be a candidate for the emission inventory, especially if an SIC code indicates that a source is a potential source of VOC emissions.

Permit and compliance files should both be consulted when developing projection inventories. The information therein on proposed new facilities or control device applications on exiting facilities will be useful to the agency in determining baseline projection year emissions.

3.4 PUBLICATIONS

Another approach to collecting point source data is to use information found in selected publications. The term "publication" in this context refers to any industrial and governmental file, periodical, list, or report that contains information on process descriptions, activity levels, or control devices for various kinds of sources, either individually or collectively. Publications are primarily used to obtain activity level information on area sources, although to some extent, they can also be employed for point sources. The types of reports that are available to employ this technique include census reports, chemical business surveys, marketing reports, trade association journals, and energy and fuel consumption reports. As a specific example, Federal Power Commission Form 67[21] contains sufficient data to make estimates of VOC emissions from fossil fueled-fired power plants. As another example, Posts Pulp and Paper Directory[22] contains equipment and production information with which to estimate approximate emissions from pulp mills. Periodicals such as The Oil and Gas Journal[23] and Chemical and Engineering News[24] intermittently list summary information on individual refineries and chemical manufacturing operations that can also be used to generate emission estimates. In most of these publications, emissions data will not be provided. Instead, emissions will have to be estimated through the use of appropriate activity level emission factors or emission-per-employee factors.

As a rule, emission estimates based on publications should only be used for point sources where a questionnaire is not received, no plant contact can be made, and for which it is necessary to get individual estimates of an emission potential. In these circumstances, the use of publications to obtain individual point source data should be considered a default mechanism to be employed only if the other approaches described in this document cannot be used. Often, the most appropriate use of such publications is to help the agency in the development of the point source mailing list. In certain instances, publications can be also useful in determining collective estimates of total capacity, production, number of employees, and planned expansion associated with particular industries. This collective information can aid the agency in scaling up the inventory to account for missing sources.

3.5 EXISTING INVENTORIES

Before the agency elects to employ one or several of the data gathering approaches detailed in the previous sections, it should examine any available inventory that may exist for the particular area of concern. If an inventory of VOC or any other pollutant has been compiled, and either is well maintained or was initially well documented, many of the data elements therein can be used directly in a new emission inventory. In many cases, the existing point source information can be made current simply by telephone calls, personal visits, or through the use of an abbreviated questionnaires. Limited contacts are desirable to minimize the effort that both the source and the agency must expend in updating the inventory data base.

If the existing inventory is computerized, a retrieval program can be developed which prints out letters and questionnaires. The questionnaires could contain existing inventory data on each source and could ask the source operators to verify or to correct the information. Such a verification form could be used with telephone contacts or plant visits. This approach should reduce the time needed to conduct an inventory and should ease the paper work burden of the source.

One point should be stressed if an existing inventory is employed. If the inventory that is used as a starting point in the current effort was not conducted primarily for VOC, a number of major VOC emitting sources may be either omitted from such an inventory or treated collectively as area sources because their emissions of other pollutants are negligible. Hence, the agency should consider the possibility that additional sources may have to be included. Conversely, there may be many sources in an existing inventory that are considered major sources of some other pollutant but not necessarily of VOC. Care should be taken in this latter instance that a significant quantity of resources is not expended in soliciting additional information from those sources that are not significant VOC emitters.

References for Chapter 3.0

1. Enforceability Aspects of RACT for Factory Surface Coating of Flat Wood Paneling, EPA-340/1-80-005, U.S. Environmental Protection Agency, Washington, DC, April 1980.

2. Overview Survey of Status of Refineries in the U.S. with RACT Requirements, EPA Contract No. 68-01-4147, PEDCo Environmental, Inc., Dallas, TX, 1979.

3. RACT Enforceability Aspects for Pneumatic Tire Manufacturing, EPA Contract No. 68-01-4147, PEDCo Environmental, Inc., Arlington, TX, March 1980.

4. Demography: Plants Subject to Phase I Surface Coating Regulations, EPA Contract No. 68-01-4141, Research Triangle Institute, Research Triangle Park, NC, May 1980.

5. Enforceability Aspects of RACT for the Chemical Synthesis Pharmaceutical Industry, EPA Contract No. 68-01-4147, PEDCo Environmental, Inc., Cincinnati, OH, May 1980.

6. Enforceability Aspects of RACT for the Rotogravure and Flexography Portion of the Graphic Arts Industry, EPA Contract No. 68-01-4147, PEDCo Environmental, Inc., Cincinnati, OH, March 1980.

7. Enforcement Aspects of Reasonably Available Control Technology Applied to Surface Coating of Miscellaneous Metal Parts and Products, EPA Contract No. 68-01-4147, PEDCo Environmental, Inc., Cincinnati, OH, May 1980.

8. Overview Survey of the Dry Cleaning Industry, EPA Contract No. 68-01-4147, PEDCo Environmental, Inc., Dallas, TX, March 1980.

9. Million Dollar Directory, Dun and Bradstreet, Inc., New York, NY.

10. Middle Market Directory, Dun and Bradstreet, Inc., New York, NY.

11. Industrial Directory, Dun and Bradstreet, Inc., New York, NY.

12. National Business Lists, Inc., 162 N. Franklin St., Chicago, IL.

13. Craig Colgate, Jr., ed., National Trade and Professional Associations of the United States and Canada and Labor Unions, Fifteenth Edition, Columbia Books, Inc., Washington, DC, 1980.

14. Nancy Yanes and Dennis Akey, eds., Encyclopedia of Assoications, Volumes 1-3, Fourteen Edition, Gale Research Company, Detroit, MI, 1980.

15. Standard Industrial Classification Manual, Executive Office of the President, Office of Management and Budget, Washington, DC, 1972.

16. P. Di Gasbarro and M. Borstein, Methodology for Inventorying Hydrocarbons, EPA-600/4-76-013, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1976.

17. Lew Heckmen, "Organic Emission Inventory Methodology for New York and New Jersey", Presented at the Emission Inventory/Factor Workshop, Raleigh, NC, September 13-15, 1977.

18. Procedures for the Preparation of Emission Inventories for Volatile Organic Compounds, Volume II, EPA-450/4-79-018, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

19. Development of Questionnaires for Various Emission Inventory Uses, EPA-450/3-78-122, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1979.

20. Compilation of Air Pollution Emission Factors, AP-42, 3rd Edition and subsequent supplements, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1977.

21. "Steam-electric Plant Air and Water Quality Control Data for the Year Ended December 31, 19__", Federal Power Commission Form 67.

22. Post's Pulp and Paper Directory, Miller Freeman Publications, Inc., 500 Howard Street, San Francisco, CA.

23. Oil and Gas Journal, Petroleum Publishing Co, 1021 S. Sheridan Road, Tulsa, OK. Weekly.

24. Chemical Engineering News, American Chemical Society, Washington, DC.

4.0 AREA SOURCE DATA COLLECTION

4.1 INTRODUCTION

The area source inventory enables an agency to estimate emissions collectively for those sources that are too small and/or too numerous to be handled individually in the point source inventory. Considerable attention should be given to the area source inventory, as significant quantities of VOC emissions will generally be associated with the important area source categories. Historically, emissions from area sources have been underestimated because of either the lack of appropriate inventory procedures or little emphasis on obtaining area source data. This chapter provides several approaches to collecting data at the county or equivalent level, from which annual or seasonal area source estimates can be derived. In addition, procedures are presented to account for emissions from source categories which have been often overlooked in previous VOC emission inventories.

4.1.1 AREA SOURCE INVENTORY STRUCTURE AND EMPHASIS

Table 4.1-1 lists those categories that are primarily inventoried as area sources in a VOC emission inventory. Sources listed in Table 2.2-1 which are not in Table 4.1-1 and are below the point source inventory cutoff can also be collectively tabulated and reported as area sources. The importance of area source categories may vary from area to area. In certain areas, other sources of local importance may need to be included, or additional subcategories may need to be defined. The area source categories in Table 4.1-1 can be divided into two broad groups characterized by the emission mechanism: (1) evaporative emissions and (2) fuel combustion emissions. Most evaporative emission sources with the exception of service stations, are characterized by some type of solvent use. Service stations emit gasoline vapors as a result of various loading and fueling operations.

As is discussed in more detail in subsequent sections of this chapter, some of the source categories in Table 4.1-1 will usually be handled entirely as area sources. However, some source categories will be handled only partially as area sources if a portion of the facilities in a category is large enough for individual treatment as point sources. It is important in this latter case that care be taken not to double count sources emissions in both the point and area source inventories. Area source emission totals should be adjusted downward to reflect emissions accounted for in the point source inventory.

The selection and structuring of area source categories is an important aspect of the planning process that affects the resources required for inventory completion as well as the inventories usefulness in the agency's ozone control program. Generally, highway vehicles will be the largest VOC emitting category and should be emphasized accordingly. All of the evaporative loss sources may be important, especially those covered by Control Techniques Guidelines. Special attention should be given to these VOC sources as well.

Table 4.1-1. Area Sources of VOC Emissions.

Evaporative Loss -

Gasoline Service Stations (and other outlets)
- Tank truck unloading (Stage I)
- Vehicle fueling (Stage II)
- Storage tank breathing losses

Solvent Users
- Degreasing, small industrial/commercial
- Drycleaning
- Surface coatings
    - Architectural
    - Auto body refinishing
    - Other small industrial
- Graphic arts
- Commercial/consumer solvent use
- Cutback asphalt
- Pesticides

Combustion -

Highway Mobile Sources
- Light duty vehicles (LDV)
- Light duty gasoline powered trucks <6000 lbs (LDT1)
- Light duty gasoline powered trucks 6000-8500 lbs (LDT2)
- Heavy duty gasoline powered trucks (HDG)
- Heavy duty diesel powered trucks (HDD)
- Motorcycles

Stationary Source Fossil Fuel Combustion (by fuel type)
- Residential
- Commercial/institutional
- Industrial

Non-highway Mobile Sources
- Aircraft (Military, civil, commercial)
- Railroad locomotives
- Vessels
- Off highway vehicles

Solid Waste Disposal
- On site incineration
- Open burning
- Structural fires
- Field/slash/forest fire burning

Because an important use of the inventory is to study the effects of applying various control measures, the area source categories should be defined so that emission reductions from anticipated controls on area sources can be readily summarized from the data maintained in the area source files. For example, if the effect of vapor recovery on tank truck unloading emissions at service stations (Stage I control) is to be evaluated, then these operations should be distinguished from vehicle fuel tank loading (Stage II operations) emissions. As another example, in order to estimate the effect of RACT on dry cleaning plants, those systems using perchloroethylene should be maintained separately from those using petroleum (Stoddard) solvents because of the different control technologies that may be applied to each system. Judicious definition of area source categories will also help the agency exclude nonreactive compounds from the emission totals. In this regard, if separate emission totals are maintained for different solvents in the inventory, most of the nonreactive halogenated solvents can be readily identified.

4.1.2 SOURCE ACTIVITY LEVELS

Area source emissions are typically estimated by multiplying an emission factor by some known indicator of collective activity for each source category at the county (or equivalent) level. An activity level is any parameter associated with the activity of a source, such as production or fuel consumption, that may be correlated with the air pollutant emissions from that source. For example, the number of landings and takeoffs (LTO) provides an estimate of aircraft activity at an airport. In this example, the number of LTOs can be multiplied by appropriate emission factors to estimate airport emissions. As another example, the total amount of gasoline handled by service stations in an area can be used to estimate evaporative losses from gasoline marketing. In this case, to estimate total emissions from this source category, the gasoline handling activity can be multiplied by an emission factor representing all of the individual handling operations at each service station.

4.1.3 METHODS FOR ESTIMATING AREA SOURCE ACTIVITY LEVELS AND EMISSIONS

Several methodologies are available for estimating area source activity levels and emissions. Estimates can be derived by (1) treating area sources as point sources, (2) surveying local activity levels, (3) by apportioning national or statewide activity totals to local inventory areas, (4) using per capita emission factors and (5) emissions-per-employee factors. Each approach has distinct advantages and disadvantages when used for developing emissions estimates, as discussed below.

1. Applying point source methods to area sources - Small sources that would normally be treated as area sources may be handled as point sources for several reasons. First, collective activity level estimates may not be readily determinable for certain source categories. Bulk plants are an example of this. According to the CTG summary in Appendix C, a typical gasoline bulk plant emits only 17 tons of VOC per year. This emission rate would normally be below the agency's point source cutoff level. However, because the area source procedures used for determining gasoline sales in an

area will probably not yield an estimate of the amount of gasoline transferred through bulk plants, the agency may need to elicit this information from each plant by using point source procedures.

In other cases, sufficient data may be available on individual sources to allow the agency to estimate activity levels and emissions for each facility. For example, records may be available from another agency that show the location and amount of solvent handled by each dry cleaner within the inventory area, in which case the inventorying agency may calculate emissions for each plant. At this point, the agency must decide whether an individual point source record will be coded and maintained for each facility or whether the resulting individual activity levels and emission estimates will be collectively handled in the area source inventory. This decision will depend on (1) the resources available for the point source inventory and (2) whether the agency elects to handle sources individually or collectively in the projection year inventory. In this latter regard, more accurate projections will result if sources are treated as point sources, because individual control reductions can be estimated for each facility.

2. Local activity level surveys - In some instances, collective activity level estimates for a given catgory may be available from a local source. For example, local trade associations may have data on the amount and types of architectural surface coating, or the amount and types of dry cleaning solvents used in an area. Tax, highway, energy, and other state or local agency records may provide collective activity level estimates for other area source categories, including gasoline sales or cutback asphalt use. Hence, the inventorying agency should survey various local associations and agencies to determine what information is maintained for the area that can be used in the area source inventory. Specific associations or agencies that may be contacted for selected area source activity level information are suggested in the following sections of Chapter 4.

3. Apportioning state or national totals to the local level - If countywide activity level information is not available locally, state totals may be apportioned to compute local estimates. For example, the quantity of fuel used in railroad locomotives is generally available at the state level from the Bureau of Mines. Fuel use can be approximated at the local level by apportioning statewide fuel use to the county level on the basis of miles of track per county. Residential, commercial, and industrial fuel combustion are other categories that are commonly handled in this manner. Major drawbacks of this approach are that additional data and resources are needed to apportion activity level estimates to the local level, and accuracy is lost in the process. If state level data are not available and no alternatives are accessible, then national data may have to be apportioned to the local inventory area. However, apportioning national data to the local level is generally less accurate than most available methods and should be done only when absolutely necessary.

The National Air Data Branch of EPA uses state and national totals from various available publications to estimate area source emissions at the county level for NEDS. Those interesed in obtaining NEDS emission estimates for particular area sources in specific counties should contact their EPA Regional Office or the National Air Data Branch, MD-14, U.S. Environmental

Protection Agency, Research Triangle Park, NC 27711. In general, these NEDS area source estimates will not be as sensitive to local conditions as estimates made by an agency using locale-specific information. The techniques used in NEDS for developing area source estimates are described in References 1-3.

4. Per capita emission factors - Sources in certain area source categories are not only numerous and diffuse, but are difficult to inventory by any of the above procedures. As an example, solvent evaporation from consumer and commercial products as waxes, aerosol products and window cleaners neither can be routinely determined by the local agency from any local sources nor will any kind of survey generally be possible that will yield such information. The use of per capita factors is based on the assumption that, in a given area, emissions can be reasonably associated with population. This assumption is valid over broad areas for certain activities such as drycleaning, architectural surface coating, small degreasing operations and solvent evaporation from household and commercial products. Per capita factors for these categories are suggested in the following sections of this chapter. Per capita factors should not be developed and used indiscriminately for sources whose emissions do not correlate well with population. Large, concentrated industries, such as petrochemical facilities, should not be inventoried by per capita factors.

5. Emissions-per-employee factors - This approach is conceptually equivalent to using per capita factors, except that employment is used as a surrogate activity level indicator rather than population. Emissions-per-employee factors are usually used to estimate emissions for those source categories for which a Standard Industrial Classification code has been assigned and for which employment data (typically by SIC) at the local level are available. Generally, this involves SIC categories 20-39, as shown in Table 3 of Chapter 3. Since, in most cases, a large fraction of VOC emissions within SICs 20-39 will be covered by point source procedures, the emissions-per-employee factor approach can be considered a back up procedure to cover emissions from sources that are below the point source cutoff level. This approach can also be used where the agency only surveys a fraction of the area sources within a given category. In any case, employment is used as an indicator to "scale up" the inventory to account collectively for missing sources and emissions in the area source inventory. Parameters other than employment, such as sales data or number of facilities can be used to develop emission estimates. However, employment is generally the most readily available parameter. Scaling up is discussed in detail in Chapter 6.

4.1.4 CONTENTS OF CHAPTER 4

The remainder of this chapter discusses specific methodologies that may be used to determine emissions for the more important source categories shown in Table 4.1-1, except for highway vehicles. Chapter 5 is entirely devoted to a discussion of highway vehicle inventory procedures. In each case, alternative approaches are presented that vary in complexity, cost, and in the accuracy of the resulting emission totals. Although certain approaches may be recommended, local data may suggest the use of a alternative procedures in a given situation.

4.2 GASOLINE DISTRIBUTION LOSSES

A generalized flowchart of gasoline marketing operations is shown in Figure 4.2-1. This flowchart depicts the operations typically involved in transporting gasoline from refineries to final consumption in gasoline powered vehicles. As indicated in Figure 4.2-1, evaporative emissions occur at all points in the distributive process. The operations generally inventoried as area sources are (1) gasoline dispensing outlets and (2) gasoline tank trucks in transit. Bulk terminals and gasoline bulk plants, which are intermediate distribution points between refineries and outlets, are usually inventoried as point sources.[4] Diesel fuel is excluded from consideration due to its low volatility.

VOC emissions from gasoline dispensing outlets result from vapor losses during (1) tank truck unloading into underground storage tanks, (2) vehicle fueling, and (3) underground storage tank breathing. When inventorying evaporative losses from this source category, each of these activities should be tabulated separately, so that various control reduction measures may be readily evaluated. EPA has made available Control Techniques Guidelines (CTG) for Stage I operations covering gasoline vapors emitted during storage tank filling.[5]

Service stations are the primary retail distributors for gasoline. Gasoline also can be purchased from other types of businesses or stores, such as auto repair garages, parking garages, and convenience stores. In addition, gasoline may be distributed to vehicles through various non-retail outlets. Because outlets other than service stations account for roughly a quarter of all gasoline handled, care should be taken that they are covered in the area source inventory.[4,5]

4.2.1 DETERMINING GASOLINE SALES

Area source gasoline evaporative losses can be inventoried in several ways. The most accurate approach is to acquire gasoline sales data which can be multiplied by a composite emission factor to determine evaporative losses. Gasoline sales statistics are collected and maintained by petroleum distributors and state motor vehicle and fuel tax offices, as well as federal and local government agencies involved in transportation planning and energy management. The statistics are developed from delivery records which are collected from drivers, compiled, and sent to petroleum company accounting offices. These statistics are summarized by county or other local political jurisdiction and are forwarded to the state tax office.[6] Thus, as the tax is collected per gallon sold, the actual total gasoline consumption within a jurisdication can be back calculated with the tax formulas. Calculation of fuel consumption from fuel tax data may already be done in some transportation planning agencies. Once derived, tax-calculated consumption should be cross checked with data from associations of service station owners and operators, oil company distributors jobbers and other local sources.[7] Cross-checking is important, since gasoline for non-highway uses and gasoline distributed to government agencies may not be taxed. Therefore, care should be taken that all gasoline consumed in the inventory area is accounted for, including that dispensed at marinas, airports, military bases, and government motor pools, as well as service stations.

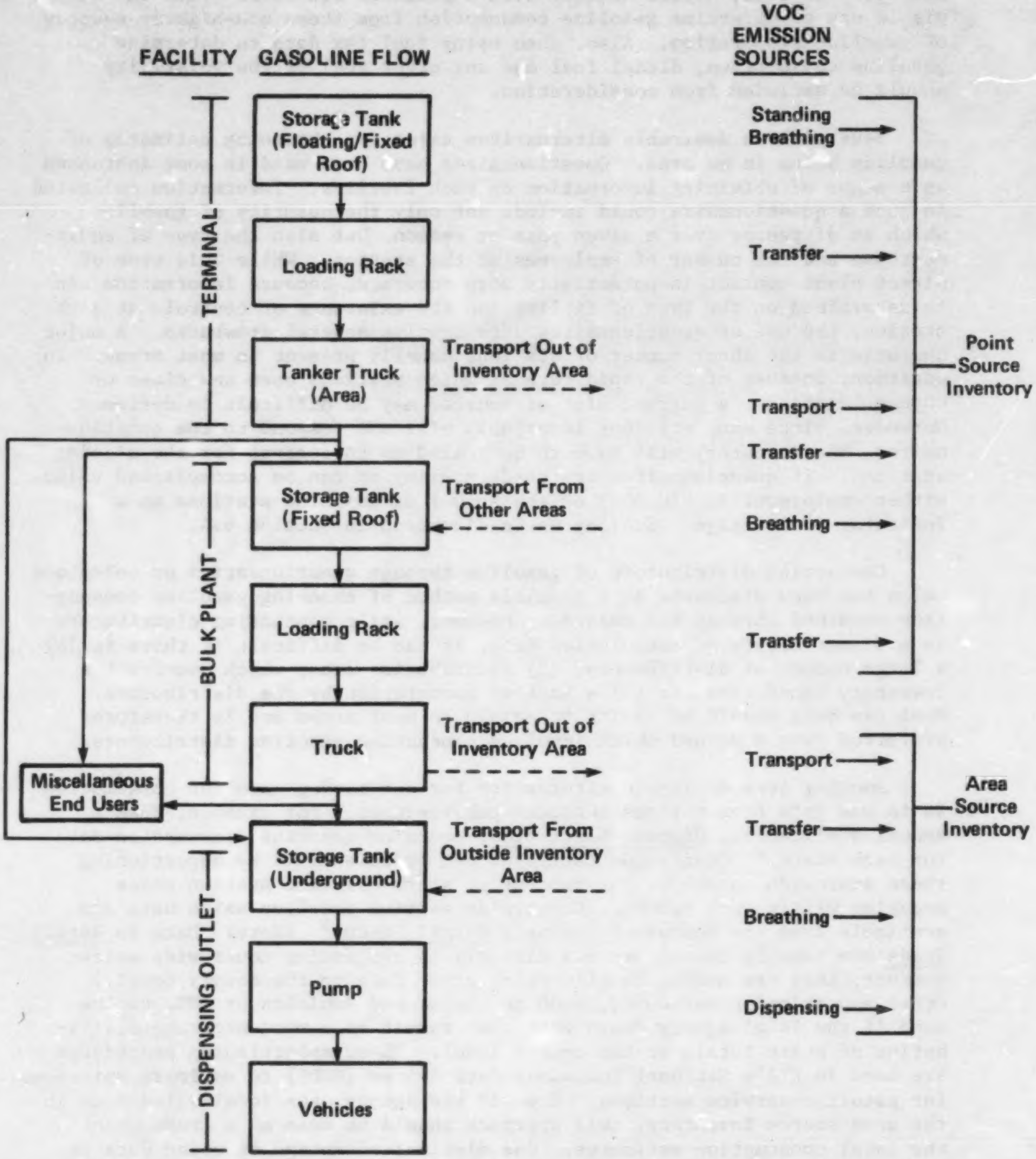

FACILITY
GASOLINE FLOW
VOC EMISSION SOURCES
TERMINAL
BULK PLANT
DISPENSING OUTLET
Storage Tank (Floating/Fixed Roof)
Loading Rack
Tanker Truck (Area)
Storage Tank (Fixed Roof)
Loading Rack
Truck
Miscellaneous End Users
Storage Tank (Underground)
Pump
Vehicles
Transport Out of Inventory Area
Transport From Other Areas
Transport Out of Inventory Area
Transport From Outside Inventory Area
Standing Breathing
Transfer
Transport
Transfer
Breathing
Transfer
Transport
Transfer
Breathing
Dispensing
Point Source Inventory
Area Source Inventory

Figure 4.2-1. Gasoline Marketing Operations and Emission Sources[4].

Gasoline distributors may be able to provide consumption data on these sources. However, direct contact with a possible source is often the only viable way to determine gasoline consumption from these non-highway sources of gasoline evaporation. Also, when using fuel tax data to determine gasoline consumption, diesel fuel and any other fuel of low volatility should be excluded from consideration.

Several less desirable alternatives exist for obtaining estimates of gasoline sales in an area. Questionnaires have been used in some instances as a means of obtaining information on each facility. Information collected in such a questionnaire could include not only the quantity of gasoline which is dispensed over a given year or season, but also the type of equipment use and the number of employees at the station. While this type of direct plant contact is potentially more accurate, because information can be determined on the type of filling and the existence of controls at each station, the use of questionnaires does involve several drawbacks. A major obstacle is the sheer number of stations usually present in most areas. In addition, because of the rapid rate at which stations open and close or change locations, a current list of sources may be difficult to define. Moreover, since many stations invariably will not respond to the questionnaires, the inventory will have to be scaled up to account for the missing stations. If questionnaires are used, scaling up can be accomplished using either employment in SIC 5541 or the number of gasoline stations as a indicator of coverage. Scaling up is discussed in Section 6.4.

Contacting distributors of gasoline through questionnaries or telephone calls has been discussed as a possible method of checking gasoline consumption obtained through tax records. However, while contacting distributors is a direct source of consumption data, it can be difficult if there is (1) a large number of distributors, (2) distribution areas which overlap the inventory boundaries, or (3) a lack of cooperation by the distributors. Fuel tax data should be easier to obtain in most areas and is therefore preferred over a method which involves contacting gasoline distributors.

Another less desirable alternative for estimating gasoline consumption is to use data from various national publications. For example, FHwA's annual publication, Highway Statistics, contains gasoline consumption data for each state.[8] Countywide estimates can be determined by apportioning these statewide totals by the percent of state gasoline station sales occuring within each county. Countywide service gasoline sales data are available from the Census of Business Retail Trade.[9] (Note: Data in Retail Trade are usually too old to use directly in estimating countywide sales; however, they are useful in allocating other data to the county level.) Other apportioning variables, such as registered vehicles or VMT, can be used if the local agency feels that they result in a more accurate distribution of state totals at the county level. These apportioning procedures are used in EPA's National Emissions Data System (NEDS) to estimate emissions for gasoline service stations. Even if the agency uses local sales data in the area source inventory, this approach should be used as a cross check of the local consumption estimates. One distinct advantage of using data in Highway Statistics is that sales are tabulated by month, thus facilitating a seasonal adjustment of the gasoline station emission totals.

Another alternative for estimating gasoline sales is to use VMT data available as a result of the ongoing transportation planning process. This alternative is not generally recommended for several reasons. First, it requires local information on both the percent of VMT attributable to diesel versus gasoline fuel and the average miles-per-gallon fuel efficiency of the gasoline powered motor fleet. None of these data may be available locally, and the use of nationwide averages may introduce errors in certain applications. Moreover, highway travel will not account for all gasoline sold at various outlets. Some fraction of the gasoline is consumed in various off-highway applications. Hence, because less data intensive and more accurate procedures are usually available in any area to estimate gasoline sales, the VMT based approach generally should not be considered.

Using state or local air pollution permit files for inventorying gasoline dispensing outlets is not likely to be an effective alternative. Permit information is not usually collected because of the large number of stations and because each stations's emissions are much lower than traditional point source cutoff levels. Registration systems are being attempted in some states whereby major retail chains are required to compile and submit service station lists.[6] Generally, such a detailed approach is not warranted when gasoline distribution data will yield adequate emission estimates.

4.2.2 ESTIMATING GASOLINE DISTRIBUTION EMISSIONS

Whatever approach is used to account for gasoline consumption, the flow of gasoline throught the inventory area should be mapped. The best approach is to develop a chart depicting overall gasoline flow within the geographical area in question, from the point of entry, through bulk storage, to service stations and vehicle loading operations. Figure 4.2-1 can serve as the basis for such a flowchart. Construction of this flow chart provides a valuable overview of the gasoline distribution system and facilitates detection of gross anomalies in the distribution data.

Once an estimate of total gasoline sales is made, gasoline dispensing emissions can be estimated using the average emission factors shown in Section 4.4 of AP-42.[10] To facilitate the subsequent development of control strategy estimates, separate subcategories should be maintained for (A) tank truck unloading, (B) vehicle fueling, (C) underground tank breathing losses, and (D) tank truck transit losses. When evaluating control scenarios, tank truck unloading and vehicle refueling are defined respectively as Stage I and Stage II controls. A detailed description of gasoline marketing operations is available in Reference 4.

4.2.2.1 Tank Truck Unloading (Stage I)

Emissions from tank truck unloading are affected by whether the service station tank is equipped for submerged, splash or balance filling. Therefore, information must be obtained on the fraction of stations using each filling method. A weighted average emission factor can then be based on the quantity of gasoline delivered by each method. A survey of several service stations in the area will produce an estimate of the number of stations employing each filling method. Trade associations are another source of information on station characteristics. Information from major brand owner/operators may also be readily available but should be used with care, as company policy may direct the use of certain equipment not representative of all stations within an inventory area. Recent studies in two U.S. cities suggest that 70 to 95 percent of service stations are equipped for submerged filling, with the remainder employing splash filling.[11-14] Balanced filling, (Stage I vapor recovery), is employed at very few of the stations in these study areas. Caution is urged when adapting these percentages, because they may change rapidly in the direction of more submerged filling and balanced filling. Hence, use of current, local data are recommended.

4.2.2.2 Vehicle Fueling and Underground Tank Breathing

Losses from vehicle fueling, including spillage, and from underground tank breathing are determined by multiplying gasoline throughput by the appropriate AP-42 emission factors. Gasoline sales data can be used as a collective measure of gasoline throughtput. Determining which service stations have vehicle refueling (Stage II) emissions controls is important in projection year inventories. If Stage II controls are planned in a projection year, a composite emission factor will have to be determined representing the mix of controlled and uncontrolled refueling operations in the area. At present, Stage II controls are not widely implemented. Underground tank breathing may be affected by Stage II controls but are unaffected by Stage I controls.[4]

4.2.2.3 Losses from Gasoline Tank Trucks in Transit

Breathing losses from tank trucks during the transport of gasoline are caused by leaking delivery trucks, pressure in the tanks, and thermal effects on the vapor and on the liquid. A worst case situation arises if a poorly sealed tank has been loaded with gasoline and pure air becomes saturated. During the vaporization process, pressure increases and venting occurs.[4]

Emission factors for gasoline trucks in transit are given in Section 4.4 of AP-42. These factors are given in terms of $lb/10^3$ gallons of gasoline transferred in two modes: (1) tanks loaded with fuel and (2) tanks returning with vapor. For convenience, these factors may be added and applied to each round trip delivery.

Because some gasoline is delivered to bulk plants rather than delivered directly to service stations from bulk terminals, the amount of gasoline transferred in any area may exceed the total gasoline consumption, due to the additional trips involved. Emissions should be based on total gasoline transferred rather than on consumption. As an example, if gasoline sales in an area are 300 million gallons per year, and 50 million gallons of this goes through bulk plants, then 350 million gallons is transported by tank truck and is the appropriate figure to use to estimate transit losses. As a nationwide average, roughly 25 percent of all gasoline consumed goes through bulk plants.[4] Hence, gasoline distribution in an area could be multiplied by 1.25 to estimate gasoline transported. Because this percentage will vary so much from area to area, the amount of gasoline handled by bulk plants should be obtained from the point source inventory and be used in making this adjustment. Emissions from this source will generally be minimal in most areas. Hence, a great deal of effort is not warranted in making this adjustment.

4.3 STATIONARY SOURCE SOLVENT EVAPORATION

Solvents are any liquid organic compounds (or groups of compounds) that are used to dissolve other materials. Solvent use can be broadly classified into two categories: (1) cleaning, including degreasing and drycleaning, and (2) product application, such as surface coating, printing, and pesticides, where the solvent serves as a vehicle for the product being applied. Each of these two types of solvent use results in some or all of the solvent being evaporated into the atmosphere.

The widespread use of solvents in all sectors of the economy makes inventorying VOC emissions a difficult task. The most accurate means to account for solvent use in the inventory is to identify as many sources as possible using the point source methods in Chapter 3. Unfortunately, because so many small solvent users are present in most, especially urban, areas, all of these small sources cannot be economically handled as point sources. Hence, area source procedures are necessary to include these small solvent users in the VOC inventory. The source categories covered in Section 4.3 are shown in Table 4.1-1. In certain areas, other solvent evaporation sources may be of local importance, and should be included in the area source inventory.

4.3.1 DRY CLEANING

Dry cleaning operations vary in size, type of service, and type of solvent used. Industrial, commercial, and self service facilities clean not only personal clothing, but also uniforms, linens, drapes, and other fabric materials. Three basic solvent types are used in drycleaning: petroleum (Stoddard), perchloroethylene ("perc"), and trichlorotrifluoroethane (Freon 113). Perchloroethylene is used in approximately 80 to 90 percent of all dry cleaning establishments and constitutes about 70 percent of all cleaning solvent consumed. Almost all other establishments use petroleum solvent. Fluorocarbons represent only a small percentage of dry cleaning solvent use.[15-18]

VOC emissions from drycleaning vary with the type of process and solvent used. Perchloroethylene systems emit less VOC for a given quantity of clothes cleaned due to the higher cost of synthetic solvents, while petroleum solvent operations typically have greater evaporative losses. VOC emissions occur mainly from the dryer and the filter muck treatment systems. Miscellaneous fugitive losses occur from valves, flanges and seals as a result of poor maintenance. Detailed process descriptions and information on emissions and controls can be obtained from References 16 and 17 as well as AP-42.

Both point and area source methods can be used to inventory dry cleaners. Industrial dry cleaning is done at large plants whose emissions will usually exceed 100 tons of VOC per year and should be inventoried by point source procedures described in Chapter 3.

Commercial and self service dry cleaning facilities typically emit less than 10 tons per year and large numbers of these facilities may operate within an urban area. A number of area source methods may be used in conjunction with point source procedures to inventory commercial and self service dry cleaning emissions. Optimally, all plants may be handled using point source procedures. The easiest way to accomplish this is to send brief survey forms to each plant or to a representative sample of plants identified in the yellow pages of the telephone directory. An example of such a form is shown in Appendix D. In general, all that is needed to develop an area source emission total from such a survey is information on the quantity of solvent annually consumed at every plant below the point source cutoff level. Emissions are assumed equal to the total quantity of makeup solvent consumption in the area. Information should also be obtained on the type of solvent used at each plant and on any control measures in place. If incineration is practiced at any petroleum plant, emissions from that plant will not equal to makeup solvent consumption, but rather, will be reduced according to the efficiency of the control device. In contrast, when the more common nondestructive control measures are employed, such as condensers and adsorbers, emissions approximate makeup solvent consumption, because the collected solvent is cycled for reuse in the process. Because the agency may elect to send questionnaires to only a sample of dry cleaners below the cutoff level, the resulting emission totals from the point source inventory and the area source survey should be scaled up to account for missing emissions. Scaling up should be based on (1) employment within SICs 7215, 7216, and 7218 or (2) number of plants covered by the point source survey. If employment is used as the coverage indicator, the survey form should also ask for the number of employees working at each plant. Scaling up is discussed in detail in Chapter 6.

As a recommended alternative to handling all dry cleaners as point sources the following factors may be applied to estimate nonindustrial dry cleaning emissions within a broad area:

Commercial plants: 1.2 lb/capita-yr
Self service (coin-op) plants: 0.3 lb/capita-yr

If any commercial or coin-op plants are known to be included in the point source inventory, the emission estimates resulting from the above per capita factors must be reduced accordingly. About 30 percent of the above per capita factor for commercial plants represents petroleum solvent whereas the remaining 70 percent of the commercial plant solvent and all of the coin-op solvent are perchloroethylene. The use of trichlorotrifluoroethane can be assumed to be nominal when applying these per capita factors.[18]

The following example illustrates the use of these factors.

Example: An urban area with an inventory base year population of 1,032,500 people has been inventoried by questionnaires sent mainly to large industrial dry cleaning plants. The questionnaires identified an industrial dry cleaning plant using petroleum solvent of which 102 tons were emitted during the base year. Fifteen commercial dry cleaning plants were also identified, emitting a total of 105 tons of perchloroethylene and petroleum solvents.

Solution: Total commercial and self service plant emissions can be estimated by applying a per capita emission factor, as follows:

$$1{,}032{,}500 \times (1.2 + 0.3)\ \frac{\text{lb VOC}}{\text{capita-yr}} \times \frac{1\ \text{ton}}{2000\ \text{lb}} = 774\ \text{tpy}$$

Since 105 tons/yr of this 774 tons/yr are accounted for in the point source inventory, the resulting area source total for commercial and coin-op plants is:

$$(774 - 105) = 669\ \text{tons/yr}$$

Hence, total dry cleaning emissions for the area are:

$$669 + 105 + 102 = 876\ \text{tons/yr}$$

Note in this example that the commercial plant point source total is subtracted from the per capita derived emissions. Also, the industrial plant point source emissions are *not* subtracted from per capita emissions. Finally, note that these factors apply only to perchloroethylene and petroleum solvent emissions.

A small percentage of dry cleaning establishments uses trichlorotrifluoroethane (fluorocarbon 113) as a fabric cleaning solvent. Fluorocarbon 113 is classified by EPA as a nonreactive compound. Therefore information on the type of solvent used at each dry cleaning plant needs to be elicited during any plant contacts or surveys so that fluorocarbon 113 emissions can be directly excluded. Nationwide, fluorocarbon 113 is only used in about 5 percent of the coin operated units, accounting for only about 0.4 percent of total annual dry cleaning solvent consumption.[16] Hence, in most situations, little error is involved if all dry cleaning solvent is assumed to consist of perchloroethylene and petroleum solvents. The per capita factors recommended earlier exclude fluorocarbon 113.[18]

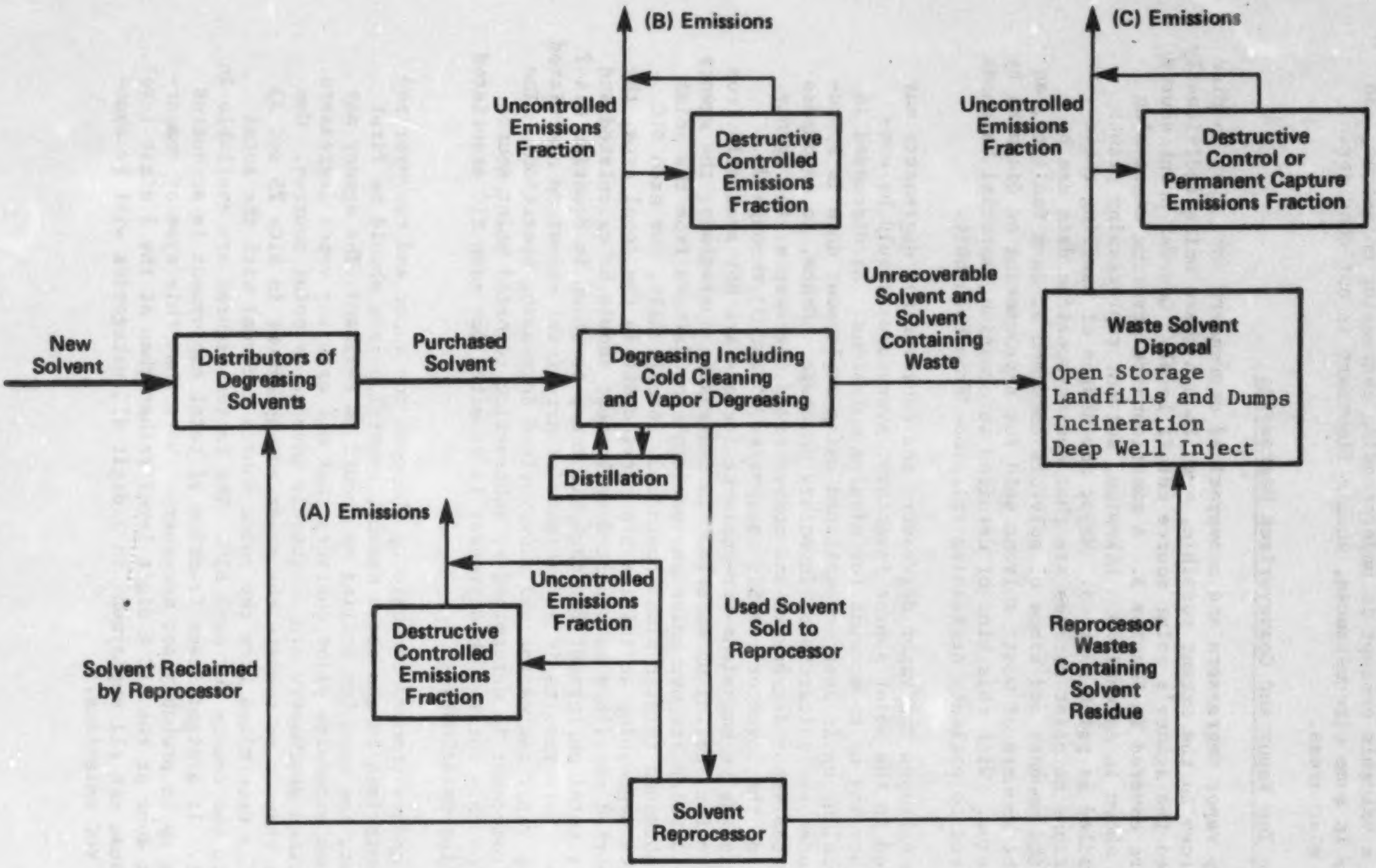
4.3.2 DEGREASING OPERATIONS

Solvent metal cleaning or degreasing operations employ nonaqueous solvents to remove soils from the surface of metal articles which are to be electroplated, painted, repaired, inspected, assembled, or machined. Metal workpieces are cleaned with organic solvents in applications where water or detergent solutions cannot do an adequate cleaning job. A broad spectrum of organic solvents may be used for degreasing, such as petroleum distillates, chlorinated hydrocarbons, ketones and alcohols.

There are basically three types of degreasers: small cold cleaners, open top vapor degreasers, and conveyorized degreasers. According to recent estimates, there are about 1,300,000 small cold cleaning units operating in the U.S. Seventy percent of these units are devoted to maintenance of servicing operations, including service stations, auto dealerships, and miscellaneous repair stations, while the remaining 30 percent are devoted to manufacturing operations. A typical cold cleaning unit emits approximately one third metric tons of VOC per year. In contrast, typical open top vapor degreasers and conveyorized degreasing units emit respectively, on average, 10 and 27 metric tons of VOC per year. These larger units are commonly used in the metal working industry. The design and operation of each of these types of degreasers will vary, as will emissions and the types of control measures used. References 16 and 20 should be consulted for detailed descriptions of processes and emissions from degreasing units.

Development of degreasing emission estimates is complicated by a number of factors. First, some degreasers will be large enough to be considered point sources, and yet, a large fraction of all degreasers will fall below any reasonable point source cutoff and thus will have to be tallied as area sources. Second, degreasing operations are not associated with any particular industrial activity. Instead, degreasing of some sort may be carried out in a wide variety of industries, including (1) metal working facilities (e.g., automotive, electronics, appliances, furniture, jewelry, plumbing, aircraft, refrigeration, business machinery, fasteners), (2) non metal working facilities (printing, chemicals, plastics, rubber, textiles, glass, paper, electric power), (3) maintenance cleaning operations (electric motors, fork lift trucks, printing presses), and (4) repair shops (automobile, railroad, bus, aircraft, truck, electric tool). Third, the practice of solvent waste reprocessing at some degreasing facilitites complicates the making of material balance estimates of solvent loss. Fourth, the fact that much of the VOC emissions associated with degreasing occurs at the solvent waste disposal site complicates the location of emissions within the inventory area. Fifth, many of the solvents used for degreasing are considered photochemically nonreactive, and hence, must be excluded from the inventory totals.[19,20]

A general chart of degreasing solvent flow in an area is shown in Figure 4.3-1. Ideally, the agency could develop an areawide estimate of total degreasing emissions from both point and area sources from the totals in this flowchart. Basically, total areawide emissions would approximately equal the amount of solvent purchased by degreasers minus that quantity of solvent sent to commercial reprocessing plants for reclamation. In practice, such a flowchart may be difficult to construct for several reasons. First, manufacturers, distributors and commercial reprocessors may be reluctant to disclose sales information. Second, they may not know how much of their product is used for degreasing as opposed to other end uses. Third, they may be unable to determine where their product is used, especially if they are not the final distributors in the area, or if they are selling to companies located at a number of sites. Fourth, some fraction of degreasing solvent most likely will be shipped from outside the inventory area.


New Solvent
Distributors of Degreasing Solvents
Purchased Solvent
Degreasing Including Cold Cleaning and Vapor Degreasing
Distillation
(B) Emissions
Uncontrolled Emissions Fraction
Destructive Controlled Emissions Fraction
Unrecoverable Solvent and Solvent Containing Waste
Waste Solvent Disposal
Open Storage
Landfills and Dumps
Incineration
Deep Well Inject
(C) Emissions
Uncontrolled Emissions Fraction
Destructive Control or Permanent Capture Emissions Fraction
(A) Emissions
Uncontrolled Emissions Fraction
Destructive Controlled Emissions Fraction
Used Solvent Sold to Reprocessor
Solvent Reprocessor
Solvent Reclaimed by Reprocessor
Reprocessor Wastes Containing Solvent Residue

$$\text{Total Degreasing Emissions} = (A + B + C) = \Sigma \begin{array}{l}\text{New Solvent}\\ \text{Produced for}\\ \text{Degreasing}\end{array} = \Sigma \begin{array}{l}\text{Purchased}\\ \text{Degreasing}\\ \text{Solvent}\end{array} - \Sigma \begin{array}{l}\text{Reprocessed}\\ \text{Degreasing}\\ \text{Solvent}\end{array}$$

Figure 4.3-1. Mass Balance of Solvent Used in Degreasing Operations.

Hence, while a valuable concept in understanding degreasing emissions, and a possibility in some circumstances, such a flowchart is not considered practical in most areas.

4.3.2.1 Open Top Vapor and Conveyorized Degreasing

Open top vapor degreasers and conveyorized degreasers should be handled as point sources to the extent possible, even though these units individually may not exceed the agency's point source cutoff level. General point source procedures are covered in Chapter 3. A questionnaire covering degreasing emissions is shown in Appendix D. Likewise, solvent reprocessing plants should be handled as point sources. Major advantages of handling these larger operations as point sources are that source-specific data can be elicited on the amounts and kinds of solvents consumed at each facility, as well as on the amounts of waste solvent sold for reprocessing or disposal by some other means. With this kind of detailed information, material balances can be employed to estimate degreasing emissions from each unit.

Because all open top vapor degreasers and conveyorized degreasers may not be covered in the point source inventory, procedures should be considered for scaling up to account for missing emissions. As discussed in Chapter 6, scaling up is best accomplished using employment data in appropriate SIC codes as indicators of inventory coverage. Hence, to encompass missing open top vapor degreasers and conveyorized degreasers, the agency should scale up the inventory in SIC categories 25 and 33 through 39. Because comprehensive emissions-per-employee factors are not available from the literature for scaling up emissions in degreasing operations, the agency will have to develop its own emissions-per-employee factors from the point source data obtained through plant contacts. Specifically, for each SIC code for which degreasing activities are carried out in the local area, the ratio of reported emissions to reported employment should be calculated and multiplied by total employment for each SIC code, as shown in Equation 6.4-2 in Chapter 6. This results in an estimate of area total emissions associated with open top vapor degreasing and conveyorized degreasing operations. The area source component is determined by subtracting reported point source emissions from this total. This process is repeated for each SIC associated with degreasing emissions.

If the agency chooses to scale up the open top vapor and conveyorized degreasing emissions in the above manner, several points should be first noted. First, the need for scaling up should be reviewed. The agency may have made such extensive plant contacts that all open top vapor degreasers and conveyorized degreasers are adequately covered as point sources. One way to check this is to compare the reported employment in SICs 25 and 33 through 39 (as determined from the point source records) with the total employment in the county for each SIC. The latter figures are available in Reference 21. If a significant fraction of total employment is accounted for, scaling up is probably not necessary. Note that this type of comparison is best done at the SIC 4 digit level rather than at the 2 digit level. This is because not all employment in 2 digit SIC categories will be associated with VOC emissions.

Second, in order to develop locale-specific emissions-per-employee factors, the agency will need to obtain the following information from each point source: (1) SIC code, (2) employment within each SIC and (3) the type of degreasing operation employed (cold cleaning, open top vapor cleaning or conveyorized cleaning). The last delineation is required to exclude cold cleaning from the derived factors. A potential drawback of this procedure is that the quantity of data the agency must collect is increased and the data may not be available for each source. If this is the case, emissions-per-employee factors can be developed from a subset of the point source data for which adequate data are available to do so.

Third, only photochemically reactive VOC should be scaled up. Information on solvent type will also have to be elicited during the plant contact, so that any resulting emissions-per-employee factors only represent reactive VOC.

These preceding three points indicate that data requirements will be substantially increased if scaling up is to account for open top vapor degreasing and conveyorized degreasing emissions. The agency should be aware of these requirements from the outset of the compilation effort. Scaling up can not be accomplished if the proper data are not available.

4.3.2.2 Cold Cleaning Degreasing

The best alternative for estimating total areawide degreasing emissions is to apply a per capita factor to cover small cold cleaning operations and to handle larger vapor degreasers as point sources. A factor of 3 pounds per capita per year is recommended for estimating small cold cleaning emissions.[18] A major advantage of this approach is that contacts to a great many different and frequently small facilities are avoided, as in the processing and storage of a great deal of data. A potential disadvantage of a per capita approach is that the correlation between degreasing emissions and population is not known. However, assuming a correlation exists is probably reasonable in making estimates for broad urban areas.

The use of a per capita factor for estimating VOC emissions from small cold cleaning operations should be qualified. First, the use of this factor will include all cold cleaning emissions in the area of application. Hence, to yield area source emissions, any cold cleaning solvent use identified in the point source inventory should be subtracted from the total. To this end, cold cleaning degreasing should be distinguished from open top and conveyorized degreasing in the point source inventory, as is discussed previously in this section.

Second, the 3 lb/capita/year factor represents only reactive VOC. A factor of 4 lb/capita-year would include all VOC of which approximately 25 percent is 1,1,1-trichloroethane; methylene chloride; and trichlorotrifluoroethane.[20] The 4 lb/capita/year factor could be used when an agency needs to adjust inventories to exclude nonreactive compounds not on the list in Chapter 2. Such a need would be encountered in only two circumstances: (1) if the EPA reactivity policy were to change, or (2) a photochemical dispersion model is to be used which excludes additional compounds as minimally reactive. However, the 3 lb/capita/year will apply in most situations and is recommended for use over a factor which includes nonreactive compounds. More discussion of excluding nonreactive VOC is included in Chapters 2 and 6.

Third, the assumption is made that most of the solvent contained in the waste evaporates and is not encapsulated or incinerated, and is not disposed of outside the inventory area. If the agency is aware of different disposal practices within its jurisdiction or is planning any control measures that would alter these practices, this factor should be changed to reflect these different practices. One estimate indicates that half of the emissions occur during disposal of the waste solvent.[20] Therefore, only this fraction of the factor should be adjusted. For example, if 400 tons of solvent waste is disposed of outside the inventory area, and 200 tons of solvent waste are brought into the inventory area, then the net disposal outside the inventory area is only 200 tons. If the 200 tons represent 25 percent of the waste solvent, which means that 75 percent remains in the inventory area, then the factor would be adjusted accordingly ($1.5 + 1.5 \times 0.75 = 2.6$).

An alternative to inventorying cold cleaner emissions by per capita factors is the use of cold cleaning emissions-per-employee factors. While this method may be theoretically more accurate than using per capita factors, because of the large number of SIC codes associated with cold cleaning operations, many such emissions-per-employee factors would be needed to scale up the inventory to encompass all cold cleaning emissions. Moreover, emissions-per-employee factors that can be applied to cover only cold cleaning operations have not yet been defined. Thus, while being theoretically more accurate, the emissions-per-employee approach will require more effort and documentation than will the per capita factor method.

4.3.3 SURFACE COATING

Surface coating operations can be separated into two groups, industrial and nonindustrial. Industrial surface coating operations for such products as appliances, automobiles, paper, fabric and cans are usually major sources of volatile organic compounds, and should be listed as point sources although small sources do exist. Nonindustrial surface coating includes refinishing of automobiles and architectural coatings which are better inventoried as area sources.

Section 4.3.3 discusses various techniques available for inventorying surface coating area sources. Emphasis is placed on the nonindustrial applications of surface coating, specifically automobile refinishing and architectural surface coating. Be aware that other small industrial surface coating operations may exist which emit less than the agency's point source cutoff level. Small metal finishing shops are an example of this. Since reliable techniques do not exist for handling small industrial surface coating operations as area sources, the agency should try to identify as many as possible in the point source inventory.

4.3.3.1 Architectural Surface Coatings

Architectural surface coatings, often called "trade paints", are used primarily by homeowners and painting contractors to coat the interior/exterior of houses and buildings and of other structures such as pavements, curbs or signs. Coating materials are applied to surfaces by spray, brush or roller, and they dry at ambient conditions. Architectural coatings differ from industrial coatings, which are applied to manufactured products and are usually oven cured. Painting contractors and homeowners are the major users of architectural coatings.[15,22]

Emissions result when the solvent which carries the coating material evaporates and leaves the coating material on the applied surface. Solvents used for thinning architectural surface coatings and for clean up after application also contribute significantly to VOC emissions associated with the architectural coating process. Waterborne coatings generally contain much less solvent than do solventborne coatings. Additional information on architectural surface coating can be found in References 15 and 22.

The most accurate method of inventorying VOC emissions from the appplication of architectural surface coatings is to obtain sales and distribution data from local wholesale and retail suppliers of solventborne paints, varnishes, and other coatings. Depending on the number of distributors, direct contacts may be made to all or, alternately, brief survey forms may be sent out if a large number of contacts must be made. Information should be elictied during such contacts on the quantity of both solventborne and waterborne coatings sold and on the average solvent content of each type of coating. Moreover, information on the use of associated solvents for thinning and cleaning must also be collected. By assuming typical densities of 6.5 and 8.6 pounds per gallon respectively, of solventborne and waterborne coatings, and applying the average solvent contents determined in the survey for each solvent type, emissions can be readily computed. Thinning solvent emissions can be similarly calculated by assuming a density of 7.0 pounds per gallon. One study suggests average solvent contents for solventborne and waterborne coatings are 54 and 8 percent by volume, respectively.[23] However, because the ranges of solvent contents in these two types of coatings can vary so greatly, local data should be used if available. A basic assumption in such calculations is that all the solvent in the coating evaporates upon application.

An advantage of using local sales data to estimate architectural surface coating emissions is that local consumption practices are taken into account, which should enhance inventory accuracy. A disadvantage is that much more work is required to develop emission estimates in this manner than is required using the per capita factor, which is discussed in the subsequent paragraph. Another disadvantage is that distributors may not be willing to divulge sales information and may not know where their product is finally used. In this last regard, sales data would necessarily have to be adjusted to account for coatings distributed into and out of the inventory area.

If local data cannot be obtained on architectural surface coating, a national average factor of 4.6 lb/capita/year is recommended for estimating architectural surface coating solvent evaporation. This factor is derived in Reference 18 from national consumption data. Thinning and cleanup solvent use, which accounts for 25 to 40 percent of all solvent loss associated with architectural surface coating, is included in this per capita factor.

None of the solvents used in architectural surface coatings or thinning and cleanup contains any of the nonreactive compounds discussed in Chapters 2 and 6. A breakdown of architectural surface coating emissions by constituent compounds is available in Reference 22.

4.3.3.2 Automobile Refinishing

Automobile refinishing is the repainting of worn or damaged automobiles, light trucks and other vehicles. Surface coating during manufacture is not considered refinishing. In automobile refinishing, lacquers and enamels are usually spray applied in paint booths. Since vehicles contain heat sensitive plastics and rubber, solventborne coatings are used which can dry in low temperature ovens. Paint booths may be equipped with paint arrestors or water curtains to handle overspray. Additional process, emissions and control information may be obtained from References 24 and 25.

One approach to inventorying auto body shops is to contact each one, or a representative sample, and to obtain information on the quantity of paint and solvent used in these operations. Such an approach is generally not recommended except for larger facilities, because of the large number of small shops in most areas and because of the unlikelihood that the shop owners or managers would be able to provide the consumption or average solvent information needed by an air pollution control agency.

An alternative approach is to use an emissions-per-employee factor and to apply it to the number of employees in SICs 7531 and 7535. Based on nationwide estimates of solvent loss from automobile refinishing and employment in these two SICs, and average factor of 2.6 ton/employee/year may be applied as an estimate of auto body shop emissions in the area.[26] Employment by SICs is available at county levels in Reference 21.

Another alternative is to use a per capita emission factor of 1.9 lb/capita/year.[19] Because auto body refinishing may be generally expected to relate to human activity, such a population based approach should serve as a reasonable approach.

Solvents used in auto body refinishing will consist entirely of reactive VOC. Thus, all solvent usage associated with auto body refinishing should be included in the inventory used in an agency ozone control program.

4.3.3.3 Other Small Industrial Surface Coating

Industrial surface coating includes the coating, during manufacture, of magnet wire, automobiles, cans, metal coils, paper, fabric, metal and wood furniture, and miscellaneous products (see Table 2.2-1). Materials applied in coating include adhesives, lacquers, varnishes, paints, and other solventborne coating material. Many surface coating facilities generate sufficient emissions to be considered major sources. However, small sources most probably will still be present in any developed inventory area.

To the maximum extent possible, small industrial surface coating operations should be treated as point sources. Only if the agency is aware of numerous facilities emitting less than its point source cutoff level but does not have the resources to contact these small facilities should the point source totals be scaled up to account for the missing emissions. Scaling up is discussed in Chapter 6.

Scaling up is usually based on employment totals within various industrial sectors. The agency will need to develop emissions-per-employee factors from data in its point source inventory on various surface coating operations. The point source totals are scaled up by applying these factors to estimates of total employment within appropriate SICs. Data on total employment by industrial sector should be obtained from local planning agencies. If local employment data are unavailable, Reference 21 presents employment by SIC at the county level.

If scaling up is attempted to cover missing small industrial surface coating, care should be taken because these operations are carried out in a wide variety of applications covered by numerous SICs. Moreover, some small operations may be found in facilities whose principal business is not typically associated with surface coating, such as manufacturing of tranformers, computers or even crockpots. Particular attention should be paid to the miscellaneous metal parts and products surface coating operations discussed in Reference 27. A thorough effort is needed to locate all of the sectors where surface coating is done, and to develop reliable factors for scaling up the inventory totals. An example for scaling up emissions is presented in Chapter 6.

4.3.4 GRAPHIC ARTS

The graphic arts or printing industry consists of approximately 40,000 facilities. About half of these establishements are in house printing services in nonprinting industries. Printing of newspapers, books, magazines, fabrics, wall coverings, and other materials is considered a graphic arts application. Five types of printing are used in the industry: letterpress, flexography, lithography, (roto) gravure, and screen process printing. Detailed descriptions of the different types of printing operations are given in References 16 and 28.

An emission factor of 0.8 lb/capita/year is recommended for estimating VOC emissions from small graphic arts facilities which emit less than 100 tons per year. Graphic arts facilities which emit more than 100 tons of VOC per year are excluded from this factor and should be inventoried by point source procedures in Chapter 3. Any emissions associated with less than 100 ton per year sources identified in the point source inventory should be subtracted from the per capita derived emissions total.[18] The following example demonstrates the use of the factor.

Example: An urban area with an inventory base year population of 808,500 people has been inventoried with a point source cutoff of 25 tons per year per plant. Plant visits and stack tests at a major publication plant equipped with rotogravure presses has determined controlled emissions of 110 tons per year at the facility. A questionnaire survey has identified four additional plants with uncontrolled VOC emissions of 18, 22, 45, and 65 tons per year, respectively.

Calculations: Per capita derived emissions = 808,500 x 0.8 lb/cap. yr.
= 649,000 lb/yr. VOC
= 320 tons/yr. VOC

Area source emissions = 320 tons
- (18 + 22 + 45 + 65) tons
= 320 - 150 = 170 tons/yr. VOC

Point source emissions = 150 + 110 = 260 tons/yr. VOC

Total graphic arts emissions = 260 + 170
= 430 tons/yr. VOC

Note that the major point source is not subtracted from the per capita derived emissions. Generally, major plants engaged in publication and package printing are typically very large emitters and thus would be included in the point source inventory.

The agency may elect to handle many of the smaller printing establishments in its inventory as point sources. A questionnaire covering graphic arts facilities is shown in Appendix D. However, because so many thousands of small printing establishments exist in the U.S., and because each unit emits, on average, less than ten tons per year of VOC, the agency may need considerable resources to handle all of these establishments in the point source data base. Moreover, care will have to be taken in (1) locating all of these small operations, because so many are found in nonprinting industries and (2) accounting for additional solvents used for thinning and cleanup. An emissions-per-employee approach is not recommended for the graphics arts industry, because so many SIC codes other than 27 (printing and publishing) would have to be covered in the scaling up process.

All of the solvents used in the graphic arts industry are considered reactive and should be included in the VOC inventory developed for use in the agency's ozone control strategy.

4.3.5 CUTBACK ASPHALT PAVING

Cutback asphalt is a type of liquified road surface that is prepared by blending or "cutting back" asphalt cement with various kinds of petroleum distillates. Cutback asphalt is used as pavement sealant, tack coat, and as a bonding agent between layers of paving material. VOCs are emitted to the atmosphere as the cutback asphalt cures and as the petroleum distillate, used as the diluent, evaporates. The diluent content of cutbacks ranges from 25 to 45 percent by volume, averaging 35 percent. Gasoline or naptha is used as the diluent in "rapid cure" cutback (RC), kerosene is used in "medium cure" cutback (MC), and low volatility fuel oil type solvents in "slow-cure" road oils (SC).[29]

VOC emissions from cutback asphalts result from the evaporation of the petroleum distillate solvent, or diluent, used to liquify the asphalt cement. Emissions occur at both the job site and the mixing plant. At the job site, VOCs are emitted from the equipment used to apply the asphaltic product and from the road surface. At the mixing plant, VOCs are released during mixing and stockpiling. The largest source of emissions, however, is the road surface itself. Additional information on cutback asphalts is found in Reference 29.

For any given amount of cutback asphalt, total emissions are assumed to be equal, regardless of stockpiling, mixing and application times. The two major variables affecting both the quantity of VOC emitted and the time over which emissions occur are (1) the type and (2) the quantity of petroleum distillate used as diluent. As an approximation, long term emissions from cutback asphalts can be estimated by assuming that 95 percent of the diluent evaporates from rapid cure cutback asphalts, 70 percent from medium cure (MC) cutbacks, and about 25 percent from slow cure asphalts, by weight percent. These percentages are applicable in estimating emissions occuring during the ozone season. Some of the diluent appears to be retained permanently in the road surface after application.[10,29]

Because the use of cutback asphalts varies so much from area to area, local records should be accessed to determine usage in the area of concern. Ideally, data should be obtained from the state or local highway department or highway contractors on the quantity of each type of cutback applied, as well as the diluent content of each. From these data, the equations or tables in Section 4.5 of AP-42 can be used to compute long term solvent evaporation. If the diluent content is not known by the local highway department personnel, default values of 25, 35, and 45 percent can be assumed for slow cure, medium cure, and rapid cure cutbacks, respectively.

All of the VOC from the petroleum-based diluents used in cutbacks is considered photochemically reactive. Thus, all evaporative emissions associated with cutback asphalt use should be included in any VOC control strategy inventory.

4.3.6 PESTICIDE APPLICATION

Pesticides broadly include any substances used to kill or retard the growth of insects, rodents, fungi, weeds, or microorganisms. Pesticides fall into three basic categories: synthetics, nonsynthetics (petroleum products), and inorganics. Formulations are commonly made by combining synthetic materials with various petroleum products. The synthetic pest killing compounds in such formulations are labeled as "active" ingredients, and the petroleum product solvents acting as vehicles for the active ingredients are labeled "inert". Neither of these toxicological designations should be interpreted as indicators of photochemical reactivity. Petroleum products are often applied directly to control insects on trees (dormant and summer oils), weeds (weed oils), and fungus on produce (light mineral oils).

Inorganic pesticides are not of interest in the inventory, since they contain no organic fraction.[15,30]

Pesticide use is typically associated with agricultural applications. However, a significant enough quantity may be used in some urban and suburban areas to warrant including pesticide emissions in the urban VOC inventory. As examples of use, muncipalities may engage in various spraying programs to control mosquitoes, tree damaging insects, or weed growth in shallow lakes or tidal marshes. Pesticides are also used in homes and gardens.

If significant agricultural activity occurs within the area being inventoried, local, state and Federal departments of agriculture should be contacted to determine the quantities and types of pesticides applied. The quantity of inorganics, which are mostly sulfur compounds, should first be eliminated from the above total. Then, as a crude estimate, the remaining synthetic and nonsynthetic total should be multiplied by a factor of 0.9 to estimate that amount that evaporates and can be considered photochemically reactive VOC.[31] A much more detailed procedure which may be applied to estimate emissions for agricultural applications is described in Reference 30. This procedure is much more data intensive and is recommended only in areas where agricultural pesticides applications are a major source of VOC.

Several studies have shown that pesticide application in agricultural areas may range from about 2 to 5 lb/yr/harvested acre.[13,30] This use includes both synthetic and nonsynthetic pesticides. These factors should be applied as a check on the figures determined from local sources.

Pesticide use for urban areas should be determined by contacting appropriate state or local agencies, including local public health departments, parks departments, highway departments, or private concerns such as utilities, exterminators, and landscapers. These groups will know the extent of pesticide application for insect control and weed killing, in addition to that used in agricultural applications. The same types of data should be obtained and the same procedures followed for estimating evaporative VOC as are suggested for agricultural pesticides.

A nominal quantity of pesticides is additionally employed in homes and gardens. This small amount is reported to be less than 0.25 lb/capita/year on average and is covered in the next section as part of commercial/consumer solvent use.[19]

All of the VOC accounted for by the above procedures is considered photochemically reactive. If a seasonally adjusted inventory is compiled, information on the seasonal application of each pesticide will have to be collected. As might be expected, not all pesticides are applied during the ozone season. For example, dormant season oils are applied during the cold months of the year.

4.3.7 COMMERCIAL/CONSUMER SOLVENT USE

Certain commercial/consumer uses of products containing volatile organics cannot easily be identified by questionnaires, surveys or other inventory procedures yielding locale-specific emission estimates. Thus, a factor of

6.3 lb/capita/year is recommended for estimating emissions from this category. This factor includes the following commercial/consumer subcategories:

	Reactive VOC
Household products	2.0 lb/cap/year
Toiletries	1.4 lb/cap/year
Aerosol products	0.8 lb/cap/year
Rubbing compounds	0.6 lb/cap/year
Windshield washing	0.6 lb/cap/year
Polishes and waxes	0.3 lb/cap/year
Nonindustrial adhesives	0.3 lb/cap/year
Space deodorant	0.2 lb/cap/year
Moth control	0.1 lb/cap/year
Laundry treatment	< 0.1 lb/cap/year
TOTAL	6.3 lb/cap/yr

The above factors are based on national estimates of solvent use in each of these end use sectors. Because of the difficulty involved in developing local consumption estimates for the myriad products comprising these categories, the local agency should generally not try to do so.[18,19]

It should not be inferred that the commercial/consumer factor is a catchall estimate to account for deficiencies in point source or area source inventories. Specifically, the factor does not include: small cold cleaning degreasing operations; dry cleaning plants; auto refinishing shops; architectural surface coating applications; graphic arts plants; cutback asphalt paving applications; and pesticide applications. These categories must be inventoried by point or area source procedures and be tabulated separately.

The major organic materials comprising this 6.3 lb/capita/yr factor are special napthas, alcohols, carbonyls and various other organics. Nonreactive halogenates used in aerosols and other products are excluded from this factor. This value should be used in a VOC control program inventory. Speciation data for use in other applications are available in Reference 18 and 19.

4.4 NONHIGHWAY MOBILE SOURCES

Nonhighway sources consist of mobile combustion sources such as railroads, aircraft, ships and barges, off-road bikes, and farm equipment, as well as lawn and garden equipment. In contrast, highway vehicles include automobiles, buses, trucks and other vehicles traveling on established highway networks. Emissions from nonhighway mobile sources are generally an order of magnitude less than the combined highway vehicle VOC emissions.

Inventory methods of highway and nonhighway mobile source emissions are distinctly different. Highway vehicles can be inventoried with traffic data compiled by transportation agencies, as discussed separately in Chapter 5. Inventory methods for nonhighway vehicles are presented in this section.

4.4.1 AIRCRAFT

Emissions of volatile organic compounds from aircraft can be significant in certain areas. Aircraft emissions are generally based on the number of landing and takeoff (LTO) cycles performed. It is simpler and more meaningful to collect LTO data from airports than fuel consumption figures. Each landing or takeoff by an aircraft is an operation. An LTO is comprised of one landing and one takeoff by an aircraft, or operations divided by two. Emissions from aircraft are commonly divided into three categories: commercial, general, and military.

Several approaches can be followed for estimating LTOs in an area. The preferred approach is to obtain information directly from each airport. Very often airports will have detailed information on their operations that can be helpful to the agency. A questionnaire, such as in Reference 32, can be used for directly acquiring LTO and other useful information from airports in the survey area. For commercial airports, questionnaire data can be supplemented by published references. Airline schedules, such as given in the Official Airline Guide, report the type of aircraft for each flight.[33] Airport Activity Statistics of Certified Route Air Carriers reports aircraft departures performed in scheduled service by aircraft types.[34] This latter reference also gives a listing of aircraft types, which may be useful in classifying commercial aircraft according to the categories listed above.

Aircraft emission factors in AP-42 are presented both in terms of the quantity of organics emitted per LTO cycle (which includes all normal operation from the time the aircraft descends through 3,000 feet in altitude on its approach and the time it subsequently reaches 3,000 feet in altitude after takeoff) and in the quantity of organics emitted per hour in each mode of LTO operation. Generally, the LTO averaged factors will be applicable in most inventory situations. However, if detailed data are available on the time spent by each aircraft in each LTO mode, such as taxi-idle and takeoff, modal emission factors should be applied. Both kinds of factors are described in Chapter 3 of AP-42.[10,35]

If LTO activity cannot be directly obtained from each airport, Federal Aviation Administration publications may be used to determine LTO cycles performed, as shown below:

1. FAA Air Traffic Activity[36] - This publication gives the number of operations performed by commercial, civil, and military aircraft at airports with FAA regulated control towers. These airports will include all the major nonmilitary airfields in the United States. Totals are given for itinerant flights, such as those that terminate at an airport different from the one at which they originated, and for local flights, including those that terminate at the same airport. To determine total LTOs for each aircraft category, itinerant and local operations should be summed.

2. Military Air Traffic Activity Report[37] - This publication gives the number of operations by military and civil aircraft performed at military airfields. All operations are summed to determine LTOs.

3. Census of U.S. Civil Aircraft[38] - This publication can be used to obtain rough estimates of the number of LTOs performed by civil aircraft at airports without FAA regulated control towers, such as smaller public airports and privately owned airstrips. The Census of U.S. Aircraft gives the number of active civil aircraft in each county. These data can be used to estimate LTOs by assuming that the total number of eligible aircraft in each county is approximately equal to the number of daily LTO cycles performed by civil aircraft. This method should be used to estimate LTOs only for airfields not included in Reference 36.

Use of the above references will give the number of LTO cycles in civil, commercial, and military classifications. By assuming the mix of aircraft types included in each category, average emission factors can be developed to compute the emissions for each category. This approach is generally acceptable for civil aircraft. However, for detailed emission inventories, it may be desirable to break down commercial and military LTOs according to type of aircraft. By identifying LTOs by the classifications given in AP-42, Compilation of Air Pollutant Emission Factors,[10] emissions may be computed to account for the aircraft mix in a certain area.

4.4.2 RAILROADS

This source category includes two types of activity: rail yard switching and road haul service. Railroad locomotives are generally not a major source. However, significant amounts of VOC can be emitted from a concentration of railroad activity in certain local areas, such as is associated with large switch yards. Emission estimates are based either on the total amount of fuel oil used by locomotives in an area or on total work output. Both of the techniques described below estimate emissions by fuel use.

The preferred approach is to contact the railroad companies for information on state or county railroad fuel use. Generally, only state totals will be available from them, since their administrative units often cross state lines. A less accurate alternative is to use Bureau of Mines data from Mineral Industry Surveys[39] to estimate use of locomotive fuel oil by state.

State fuel use can be apportioned to each county on the basis of miles of track per county, as determined from detailed state maps or obtained from the rail lines. If state maps are employed, the track mileage should be doubled in counties exhibiting significant rail yard operations. This is because operations, and hence emissions, in rail yards are usually greater than on main line track, a fact which is not determined from the use of maps. An alternative and less accurate apportioning approach is to distribute state fuel totals on the basis of county population as given in the Census of Population.[40] The population apportioning technique should be used only when it is impossible to obtain track mileage data. This technique assumes that most yard operations take place in large cities.

Residual oil, which may be used by railroads in addition to diesel fuel oil, can be accounted for if Bureau of Mines figures are used by adding the state residual oil total for railroads to the distillate oil total before apportioning to counties. The use of coal by railroads is negligible and does not need to be considered.

Once fuel oil consumption by locomotives is determined for the survey areas, the appropriate emission factors from Chapter 3 of AP-42 should be used to estimate organic emissions. Generally, the average factors in AP-42 should be used unless specific information is available on each engine type in an inventory. An example questionnaire for collecting railroad activity can be found in Reference 32.

4.4.3 VESSELS

This source category includes ocean going ships, river vessels, and small pleasure craft used on lakes and rivers. Emissions are determined for vessel travel (and dockside operations) by estimating the quantity of fuel used for each kind of vessel in the survey area. These vessels are generally a minor source of VOC emissions, but they may be included in a detailed inventory in areas where such traffic is heavy or where docking activity is considerable. A detailed discussion of vessel types and the methods used to obtain fuel consumption data is presented below.

1. Coal powered vessels: A few vessels, notably in the Great Lakes region, still burn anthracite coal. No easy methods are available for estimating local emissions for these vessels, because only nationwide fuel totals are available.[41] Thus, information on local fuel consumption can be obtained only from estimates made by port authorities or ship operators.

2. Gasoline powered vessels: This category includes small pleasure craft operated on lakes, rivers, and coastal areas. Most of these craft are powered by outboard motors, but inboards and inboard outdrives using gasoline are also included. Gasoline use for states may be estimated as followed:

Inboard gasoline consumption (gal/yr) = # registered inboards x 3 gal/hr x 10 (C) hr/yr

Outboard gasoline consumption (gal/yr) = # registered outboards x 1.5 gal/hr x 10 (C) hr/yr

The factor C is a climatic factor which accounts for a longer pleasure boating season in warmer areas. C is the number of months during which the monthly mean temperature exceeds 45°F for counties north of 43° latitude, 48°F for counties between 37° and 43° latitude, and 55°F for counties south of 37° latitude. State boat registrations are obtained from a boating industry publication,[42] but they should also be available from the state agency responsible for boat registrations. Vessels powered by inboard/outdrives are included with inboards to estimate fuel use. The fuel use factors are derived from Reference 43.

After state fuel use totals are obtained they can be apportioned to counties by county inland water surface area modified to include a surface area for any costal regions.[44] The standard method in apportioning to counties could be improved by local data. Knowledge of where boating activity actually takes place will provide more accurate county totals than will apportioning to counties only on the basis of water area. One method is to obtain gasoline sales data at marinas. This should be done for estimating emissions from dispensing outlets, and it could be directly applied to gasoline powered vessel emission estimates. Boat registrations by county, if available, may be useful, but boats are not necessarily used in the county in which they are registered in all states. Reference 44 is also deficient in that any man made reservoirs constructed since 1960 are not included. The method for accounting for vessel use in coastal areas is very poor and could be improved tremendously by local gasoline sales data.

3. Fuel oil (including diesel) powered vessels: Fuel consumption totals for these vessels, which represent the major subcategory of interest, include the fuel used by large cargo and passenger ships, oil tankers, tugboats, and all other steamships and motorships that use fuel oil.

Fuel consumption totals can be obtained by:

Questionnaire surveys of shipping and tugboat companies and contact with the local port authorities. This method provides the most accurate local data for fuel consumption rates of many of the vessels in the area. Such a survey is not often comprehensive enough to include all vessels, however, because many vessels move in and out of the port area during the year and would be difficult to contact.

Vessel movement data available from the U.S. Corps of Engineers,[45] together with fuel consumption factors and Bureau of Mines fuel consumption figures.[39] This method is much easier to implement than a questionnaire survey, and may be almost as accurate despite the generalizations that must be made to effect its use. This method is described in detail later.

Use of Bureau of Mines figures only. State totals for fuel oil sold to vessels are given in Reference 39. Not all the fuel sold for vessel use is by any means consumed within the state boundaries, however, much of the fuel may be consumed far out at sea and not in a port or waterway area. If it is assumed that 75 percent of the distillate oil figure given in Reference 39 and 25 percent residual oil total are consumed in ports and waterways within the state, a rough estimate of vessel fuel oil consumption can be obtained. This method should not be used in conjunction with a detailed emission inventory, however, and is useful mainly to obtain an order-of-magnitude emission estimate from vessel operations.

If fuel consumption totals are determined from a questionnaire survey, the fuel oil consumption figures should be simply assigned to the counties where the vessel are operated. If vessel movement data obtained from Reference 45 must be used, extensive apportioning measures are necessary. The apportioning method becomes somewhat involved, because both underway and dockside emissions should be considered. Underway and dockside emissions include the emissions that occur when a vessel is moving under its own power through a waterway and when it is maneuvering into its dock space. Average fuel consumption rates during these periods for steamships and motorships are 44 and 19 gallons per nautical mile, respectively.[46] In-port, or dockside, emissions occur when a ship operates its engines or boilers in port to provide power for ship utilities. Average fuel consumption rates are 1900 gallons per day of residual oil for steamships and 660 gallons per day for motorships.[46] The local port authority should be able to supply a figure for the average number of days a ship remains in port. If not, a figure of 3 days per vessel is typical.

Fuel consumption can be estimated from vessel movement data for fuel oil powered vessels as follows:

Step 1. Determine in-port fuel consumption.

The number of vessels entering a port can be found in Section 2 of parts 1, 2, 3 and 4 of Waterborne Commerce of the United States.[45] Section 2 lists vessel traffic on waterways for self propelled vessels and other according to type and draft of vessel and direction of trip. For the first step in the determination of in-port emissions, select the entries for ports in Section 2, and assume that only self propelled vessels with a draft greater than 18 feet will be operating under their own power when in port. Determine the number of vessels meeting these conditions that enter each port, and multiply by 3 days per vessel, or by a number recommended by the port authority, to calculate the number of vessel-days in each port. Vessel-days in port must be distributed between those ships that use residual oil and those that use distillate (diesel) oil. This procedure is illustrated as follows:

A. From Reference 39 determine the amounts of distillate and residual fuel oils sold for use by vessels in each state. Example fuel and sales for a particular state are given below:

$$\text{Distillate oil consumption} = 232 \times 10^3 \text{ bbl} = 9{,}750 \times 10^3 \text{ gal}$$

$$\text{Residual oil consumption} = 1{,}000 \times 10^3 \text{ bbl} = 42{,}000 \times 10^3 \text{ gal}$$

Convert fuel consumption figures to vessel-days:

$$\text{Distillate vessel-days} = \frac{9{,}750 \times 10^3 \text{ gal}}{660 \text{ gal/day}} = 14{,}800 \text{ vessel-days}$$

$$\text{Residual vessel-days} = \frac{42{,}000 \times 10^3 \text{ gal}}{1{,}900 \text{ gal/day}} = 22{,}100 \text{ vessel-days}$$

B. Then total vessel-days = 14,800 + 22,100 vessel-days

$$\text{Percent distillate vessel-day} = \frac{14{,}800}{36{,}900} \times 100\% = 40\%$$

C. Then at each port in this state, assign 40 percent of the total vessel-days to motorships (diesel fuel users) and 60 percent to steamships (residual fuel users).

Finally, in-port fuel consumption can be calculated by multiplying the total distillate oil vessel-days by 660 gallons per day, and the total residual oil vessel-days by 1900 gallons per day.

Step 2: Determine fuel consumption for vessels underway:

Underway emissions will be calculated for diesel fuel use only. In a typical harbor there are tugboats and small craft (draft less than 18 feet) that use diesel fuel. Because most of these do not operate their boilers or engines when in port, most of their emissions occur when the ships are underway. Vessels using residual oil also have underway emissions, which are approximately accounted for when emissions for vessels using diesel fuel are calculated by the technique described below.

Calculation of underway fuel consumption:

A. Subtract the sum for all ports of the in-port diesel fuel consumption from the state total for distillate oil consumption by vessel as given by Reference 39.

B. Distribute the remaining fuel consumption figures to ports and waterways by tonnage handled, as given in Section 1 of Waterborne Commerce of the United States. Underway fuel consumption totals are assigned to counties using the description of waterways given in Waterborne Commerce of the United States. In cases where a waterway borders more than one polictical jurisdiction, divide the fuel use equally between jurisdictions. In instances where a waterway, such as a river, passes by a series of counties, assign the emissions to counties according to shoreline mileage along the waterway.

Note that two methods have been given that can be used for a detailed survey of fuel oil use by vessels. As mentioned previously, Bureau of Mines data alone are useful only for a rough guess of vessel fuel oil use. Little can usually be gained by using both of the methods for fuel oil consumption by vessels. Vessel movement data serve as replacements for questionnaires, and vice versa. A modified version of this method would be to contact port authorities for vessel movement data. The Waterborne Commerce of the United States data are much more nearly complete, however, and should be used if at all possible. All four parts of Waterborne Commerce of the United States are not necessary for completion of a vessel fuel use inventory. Only that part that covers the geographic area being considered need be used. The choice of either of the first two methods depends on whether sufficiently thorough (or adequate) data could be obtained by a questionnaire survey to justify the time required to institute the survey. If detailed data for individual types of vessels such as tugboats, tankers and cargo ships are desired, questionnaires should be used. If only a reliable estimate of the total fuel consumption by vessels is desired, vessel movement data are adequate.

Once fuel consumption data are available, emissions can be calculated for each class of vessel by using appropriate emission factors in Chapter 3 of AP-42. If extremely detailed data are available for fuel consumption as a function of operating mode, the more detailed procedures and emission factors prescribed in AP-42 can be employed.

4.4.4 OTHER OFF-HIGHWAY FUEL USE

Off-highway internal combustion engines are both gasoline and diesel fuel powered. The first category includes farm tractors, lawnmowers, motorcycles and snowmobiles. The latter category includes farm tractors, construction equipment, emergency generator power units and compressor engines. While each of these source categories may be relatively small in many areas, their collective emission rates can be significant.

Because snowmobile activity does not correspond to the ozone season, the agency may consider ignoring this minor category in its inventory effort. Some of the other categories, however, such as tractors, lawnmowers and construction equipment, may be relatively more active during the ozone season. For many of these source categories, emissions are calculated from on the amount of fuel used by each type of equipment.

The following procedures allow emission estimates to be made for these sources, based on information found in publications and on national average conversion factors. Locale-specific techniques are not available for estimating emissions from these sources. However, to the extent that local fuel use data, or even locally derived conversion factors, are available for use in the following equations, they should be used in the emission calculations presented below.

4.4.4.1 Off-highway Motorcycles

Gasoline use is estimated by assuming that, on average, motorcycles achieve 42.5 miles per gallon and travel about 700 off highway miles per year. By using these conversion factors, state motorcycle registrations available from Reference 8 can be apportioned to the county level on the basis of population, as follows:

$$\text{County Consumption} = \text{State Registrations} \times \frac{\text{County Population}}{\text{State Population}} \text{ (gal/yr)} \times \frac{700 \text{ miles/yr}}{42.5 \text{ miles/gallon}}$$

County fuel consumption is then multiplied by the appropriate emission factors in AP-42 to estimate local emissions. In the above equation, if local mileage, fuel efficiency or county registration data are known, they should be used to estimate county consumption.

4.4.4.2 Farm Equipment

Farm tractors account for the bulk of activity in this category, with lesser amounts of fuel being used by combines, balers, harvesters, and general utility engines for irrigation and miscellaneous purposes. Both gasoline and diesel fuel can be consumed by farm machinery.

TABLE 4.4-1. USE RATES, CONSUMPTION RATES AND POPULATION DISTRIBUTION FOR HEAVY DUTY AGRICULTURAL ENGINES[43]

Device	Annual Uses (hr/yr)	Fuel consumption rate (gal/yr)		Population density (%)	
		Gasoline	Diesel	Gasoline	Diesel
Combines	71	2.34	1.5	57	43
Balers	24	2.34	1.5	100	0
Harvesters	120	2.34	1.5	0	100
General Purpose	50	3.51	1.94	50	50
Tractors	*	2.28	2.98	65	30**

*490 hr/yr Diesel, 291 hr/yr Gasoline

**About 5% is LPG, which is not included here.

State consumption of gasoline and diesel fuel for each category is determined as follows:

State consumption (gal/yr) =
Equipment population x Use (hr/yr) x Fuel rate (gal/hr)

Equipment populations and use factors can be obtained either from the Census of Agriculture[46] or derived from data shown in Table 4.4-1. County consumption of each fuel is determined by apportioning the state total for all farm equipment to counties according to number of farm tractors in each county.

4.4.4.3 Construction Equipment

County gasoline and diesel fuel use is determined as follows:

$$\text{CC} = \text{National fuel use} \times \frac{\text{State employment for SIC 16} \times \text{County population}}{\text{National employment for SIC 16} \times \text{State population}}$$

Where: CC = County consumption

National average use of gasoline and diesel fuel is shown in Table 4.4-2 below.

TABLE 4.4-2. NATIONAL FUEL ESTIMATES FOR 1973, GALLONS[43,48]

Equipment type	Gasoline	Diesel
Construction	243×10^6	$4{,}453 \times 10^6$
Industrial	612×10^6	$1{,}094 \times 10^6$
Lawn and garden	827×10^6	---
Snowthrowers	25×10^6	---
Snowmobiles	80×10^6	---

Employment data are available from Reference 21 and population data from Reference 40. If local fuel use is known, it should be used to enchance the accuracy of the resulting emission estimate.

4.4.4.4 Industrial Equipment

County gasoline and diesel fuel use by industrial equipment (forklifts, generators, pumps, miscellaneous machinery) computed as follows:

$$CC = \text{National fuel use} \times \frac{\text{County employment for SICs 10-14,20-39,50,51}}{\text{National Employment for SICs 10-41,20-39,50,51}}$$

Where: CC = County consumption

National fuel use data are available in Reference 43. Employment data are available in Reference 21. Local fuel consumption data or apportioning factors should be used when known for the area.

4.4.4.5 Lawn and Garden Equipment

Gasoline use by lawn and garden tractors, mowers, tillers, and snowthrowers, is calculated for each county based on national fuel use data in Reference 43. National fuel use is apportioned to counties on the basis of number of single unit dwellings,[49] number of days per year with minimum temperature greater than 32°F, and county snowfall.[50] Number of single unit housing structures is the primary apportioning factor, and the other items adjust for the extent of summer vs. winter related uses. The appropriate equation for apportionment of fuel use is:

$$CC = NLGC \times \frac{CUS}{NUS} \times \frac{DMTC}{DMTN} + C_1 \times NSC \times \frac{CP}{SZP} \times \frac{CS}{SZS}$$

Where: CC = County consumption

NLGC = National lawn and garden consumption (the national gasoline consumption of lawn and garden equipment other than snowthrowers)

CUS = County unit structures

NUS = National unit structures (46,780,067 single unit structures)[48]

DMTN = Days min. temp > 32°, nation (the sum of the total days for all counties in the nation: 788,335 days/year summed over all counties)[48]

DMTC = Days min. temp > 32°, county

C_1 = 0 for counties with less than 30 inches annual snowfall

C_1 = 1 for counties with more than 30 inches annual snowfall

NSC = National snowthrower fuel consumption

CP = County population

CS = County snowfall

SZP = Snow zone population (population of all counties with more than 30 inches annual snowfall: 116,049,900 people)[48]

SZS = Snow zone snowfall (sum of snowfalls in all counties with more than 30 inches annual snowfall: 101,437.74 inches)[48]

An agency may wish to ignore gasoline consumption by snowblowers in an inventory, since these emissions occur in the winter months. Consult Chapter 6 for information of seasonal adjustment of VOC emissions.

4.5 SOLID WASTE INCINERATION:

Solid waste may consist of any discarded solid materials from industrial, commercial or residential sources. The materials may be combustible or noncombustible and are often burned to reduce bulk, unless direct burial is either available or practical.

In some local areas, solid waste disposal by burning can be a significant source of organic emissions. The area source solid waste VOC emissions category includes on site refuse disposal by residential, industrial, and commercial/institutional sources. On site incineration is the unconfined burning of waste leaves, landscape refuse or other refuse or rubbish. Slash and large scale agricultural open burning are not included in this VOC emission category. Large open burning dumps and municipal incinerators are usually classed as point sources, but many smaller incinerators may be so classified, depending on the needs of the agency. For emission inventory purposes, only solid waste actually burned is of interest. Unfortunately, very little quantitative information about on site solid waste disposal is available.

Some locales have conducted comprehensive surveys of solid waste disposal practices. Where such a survey is available, it should be used to estimate solid waste quantities. Many such surveys cover only collected waste, however, and are of limited value for determining on site waste disposal quantities.

If solid waste survey data are not available, quantities are usually estimated by per capita generation factors. Nationwide, it is estimated that about 10 pounds of solid waste are generated per capita per day.[51] By proportioning the various disposal methods, waste generation can be estimated for on site incineration and open burning. In addition, data useful for estimating area source solid waste quantities are available in several surveys of nationwide solid waste disposal practices.[52-54] It should be noted that data on nationwide or regional solid waste generation may yield extremely inaccurate predicitions for local areas. The tremendous variation in solid waste disposal practices from one community to another renders such nationwide averages rough estimates at best. Furthermore, local regulations governing solid waste disposal should be taken into account. In some areas and under certain conditions, on site incineration is regulated or may be prohibited. If so, the corresponding generation factors(s) should not be applied. Under such circumstances, assume that the solid waste normally allotted to on site disposal is handled by some method not involving burning, such as landfilling or resource recovery.

4.5.1 ON SITE INCINERATION

The waste generation factors given in Table 4.5-1 may be used with appropriate emission factors in AP-42 to estimate on site solid waste incineration by residential, commercial/institutional, and industrial sources. Care should be taken in the application of these waste generation factors. If a number of on site incinerators have been identified as point sources, it may be appropriate to reduce or eliminate the area source estimates. In addition, these factors are 1975 data and should be updated to the inventory base year with procedures which can be obtained from NEDS contacts in EPA Regional offices. If data are available from registration or permit files for solid waste disposal equipment, these data may provide a more accurate estimation of on site incineration quantities then the factors given here. Reference 54 presents additional data on incinerators, such as size of units or controls, that may be useful in making more detailed estimates for on site incineration.

TABLE 4.5-1. FACTORS TO ESTIMATE TONS OF SOLID WASTE BURNED IN ON SITE INCINERATION[a]

EPA Region	Residential (Tons/1000 population/yr)	Commercial/Institutional (Tons/1000 population/ yr)	Industrial (Tons/1000 mfg employees/yr
I	52	64	125
II	11	65	180
III	4	54	560
IV	4	23	395
V	61	87	420
VI	23	33	345
VII	75	37	325
VIII	87	49	430
IX	90	5	80
X	90	29	170
National average	41	50	335

[a] References 21, 40, 52, 53.

4.5.2 OPEN BURNING

Little national data are available to estimate open burning activities. However, since many areas require open burning permits, open burning can be best estimated by contacting the most knowledgable local official and by taking into account the effects of any local open burning restrictions or prohibition. If no local estimates can be made, the waste generation factors in Table 4.5-2 may be used to estimate the quantity of solid waste to multiply by the appropriate emission factor from AP-42. Note that the factors for residential and commercial/institutional open burning are applied to rural populations. Also, these factors should be updated to inventory base year levels using procedures available from NEDS contacts in EPA Regional offices.

TABLE 4.5-2. FACTORS TO ESTIMATE TONS OF SOLID WASTE DISPOSAL THROUGH OPEN BURNING[a]

	Residential (Tons/1000 population/yr)	Commercial/Institutional (Tons/1000 population/yr)	Industrial (Tons/1000 mfg employees/yr
National average	450[b]	24[b]	160

[a] References 21, 40, 52, 53, 55.
[b] For rural population only. Open burning assumed banned in urban areas.

4.6 SMALL STATIONARY SOURCE FOSSIL FUEL USE

This source category includes small boilers, furnaces, heaters, and other heating units too small to be considered point sources. Note that both point and area source combustion equipment produce only small amounts of organics relative to most other sources. Thus, the agency may not consider it worthwhile to perform the detailed procedures given below, if its primary concern is updating the VOC inventory and if an existing inventory already includes combustion. The procedures below may be followed if a detailed VOC inventory is needed or if other pollutants from small stationary source fuel combustion are of concern. Because VOC emissions from this source are estimated by simply multiplying the typical quantity of fuel used and an appropriate emission factor, the techniques below are designed to yield fuel use data for various types of combustion equipment.

Area source stationary source fuel use may be divided into three categories: residential, commercial/institutional, and industrial. Residential dwellings are all structures containing fewer than twenty living units, so that large apartment houses are excluded. Commercial/institutional facilities are establishments engaging in retail and wholesale trade, schools, hospitals, government buildings, and apartment complexes with more than twenty units per structure. The commercial/institutional category covers all establishments defined by SIC groups 50-99. Industrial fuel combustion includes all manufacturing establishments not classified as point sources. These establishments are defined by SIC groups 19-30.[56] Collectively, the three categories account for all the stationary fuel combustion activities not usually reported as point sources.

The area source fuel use total is determined by subtracting all fuel used by point sources from the area-wide total of fuel use. Hence, before a specific methodology can be applied to calculate area source fuel use, the total fuel consumed in an area must be determined. Such data are usually obtained from fuel dealers and distributors, published references, or government regulatory agencies. Some fuel retailers maintain sales records that can be a valuable source of information for determining total fuel consumption. The information needed from fuel dealers concerns their annual sales to each source category (preferably by county). The area source totals of residential and commercial/institutional fuel consumption are then simply the fuel dealers' figures minus any fuel consumed by the fuel dealers. The accuracy of survey results will be significantly reduced if some fuel dealers are overlooked. It may be that not all fuel dealers will be able to furnish adequate information. Generally, natural gas dealers can best furnish the required data. Other dealers either are reluctant to release information, or they simply do not have the detailed breakdowns required.

Unfortunately, the above techniques cannot assure that fuel dealer sales accurately represent fuel consumption. Sales of coal to industrial sources or of wood to residential sources, for instance, may represent only a part of the total fuel consumed, as much of the fuel consumed in some areas may not come from retail dealers. Other methods should be used for those cases in which fuel dealers cannot provide adequate data on total fuel sales. It should be emphasized, however, that information provided by dealers, although perhaps incomplete, can provide insights into fuel use patterns that would not be discovered by other methods. An example questionnaire for obtaining fuel use data from fuel suppliers is included in Reference 32.

Published references are the most common sources of fuel use data. Reports produced by the U.S. Bureau of Mines contain data on fuel sales and distribution. The advantages of using this information are that data for all parts of the nation are readily available and are updated every year. The drawback to the use of this material is that fuel data are reported by state only. They are not broken down into the desired source categories, and county totals must be estimated by apportioning state totals. This geographical apportioning step, which may also be necessary for data obtained from fuel dealers, can become quite complicated and can involve a large number of calculations.

Finally, useful data may sometimes be obtained from federal and state regulatory agencies. The Federal Power Commission compiles data on fuel used by electric utilities and on natural gas company sales and pipeline distribution.[57,58] State utility commissions may be able to provide similar data. In addition, state revenue or tax departments may have data that would be helpful for determining fuel usage.

4.6.1 FUEL OIL CONSUMPTION

Data collection for fuel oil consumption covers the use of both distillate and residual oil. Distillate oil includes fuel oil grades 1, 2 and 4. Diesel fuel and kerosene also can be considered distillate oils. Nationwide, residential and commercial/institutional sources are the largest consumers of distillate oil. Residual oil includes fuel oil grades 5 and 6. In most areas, residual oil is not used by residential sources, but significant amounts may be consumed by industrial and commercial/institutional users.

Literature data must be generally relied upon to determine total fuel oil consumption. Local fuel dealers and government agencies usually have been unable to supply adequate data on fuel oil use. The data published by the Bureau of Mines in Sales of Fuel Oil and Kerosene are the most acceptable.[39] For selected years, data are also available from the Census of Manufacturers, published by the Bureau of the Census.[59] This publication is not produced annually, however, so it is of limited use for most area source inventory purposes.

A procedure for determining area source fuel consumption can be found in Census of Manufacturers and other publications.[60] This procedure involves calculating state fuel oil consumption, substracting point source consumption data, and allocating fuel oil use into county inventory area. A full discussion of this method is found in the AEROS Manual Series, Volume II.[2]

Due to the complexity of the method, it may be very cumbersome to apply on a large scale. Persons who wish to obtain the computer output for selected counties or further information may contact their EPA Regional office or the National Air Data Branch, U.S. Environmental Protection Agency, Mail Drop 14, Research Triangle Park, NC 27711.

A simplified version of the method (discussed in AEROS) can be employed, but it sacrifices the accuracy of the results. Variations of the method may include using different correlative relationships to predict fuel oil use. For instance, to predict distillate oil used for space heating, equations of the following types may be use:

$$\text{Oil consumed} = \frac{\#\text{ of oil burners} \times \text{avg size (BTU/hr)} \times 8760\text{ (hr/yr)} \times \text{load}}{140{,}000\text{ BTU/gallon}}$$

or,

$$\text{Oil consumed} = \frac{\#\text{ of oil burners} \times \text{heat loss (BTU/hr)} \times \text{heating degree days} \times \text{use factor}}{140{,}000\text{ BTU/gallon} \times \text{Design Range (°F)}}$$

where the heat loss is dependent on the average square feet of building space. The design range is the difference between inside temperature and the design outside temperature for an area.[60]

Use of these relationships requires collection of substantially more source data and determination of local load and use factors. Fuel oil trade association publications,[61] oil dealers, and utility companies may be able to provide some of this information. Modifications of the above equations may provide relationships for predicting residential, commercial/institutional, or industrial space heating fuel oil use, which can be summed to obtain grid, county or state totals. The derived totals should be adjusted to conform with the state totals given in literature.[39] This step corrects for variations in the parameters used in the above equations.

4.6.2 COAL CONSUMPTION

A determination of both anthracite and bituminous coal consumption may be necessary. Anthracite, or hard coal, is found almost exclusively in Pennsylvania and is used in significant quantities only in states within easy shipping distance from Pennsylvania. Anthracite may be consumed by all source categories, although most is used by residential sources. Mining of bituminous, or soft coal, is more widespread than anthracite, so that bituminous coal is available in most areas of the country. Also considered as bituminous coal are lower grades of subbituminous coal and lignite. Bituminous coal is often favored for use by electric utilities, industries and coke producers. Bituminous coal is used in some areas for residential and commercial/institutional heating.

The same general techniques used for fuel oil may be adapted to determine coal consumption. Residential coal use is calculated for each county with on the following equation:

$$\text{Tons of coal per dwelling unit} = 0.003874\, e^{[7.6414 - (1000/\text{degree days})]}$$

The number of dwelling units using coal for space heating is obtained from Reference 56 and is updated annually with additional data from Bureau of Mines or Bureau of the Census data. Degree days are obtained from Reference 50. The coal use predicted by the above equation is distributed between anthracite and bituminous coal based on the estimated residential market share of each.[48] Use of coal for other than space heating purposes is ignored. Methods used for calculation of commercial/institutional and industrial coal use are basically the same as those used for fuel oil. State totals are obtained from References 62 and 63.

4.6.3 NATURAL GAS AND LIQUIFIED PETROLEUM GAS CONSUMPTION

Few problems should be encountered in determining natural gas use by county. Natural gas companies are usually excellent sources of data. If gas companies are unable to supply adequate data, information from the Federal Power Commission,[58] state utilities commissions, and literature may be used. Liquified petroleum gas (LPG) use may also be considered in area source inventories. The LPG contribution to total emissions is not significant in most areas. Wherever LPG use is considerable, however, it may be reported as "equivalent natural gas" by assuming for emissions that each gallon of LPG is equivalent to 100 cubic feet of natural gas.

Residential natural gas use by county is computed using the following equation:[48]

Therms of Natural Gas Consumed =

$$47.5 \times A \times B^{0.367} \times \left(\frac{C}{D}\right)^{0.588} \times E^{0.125}$$

Where: A = total number of natural gas customers

B = annual heating degree days

C = number of dwelling units using natural gas for space heating

D = the larger of the number of dwelling units using natural gas for cooking or hot water heating

E = median number of rooms per dwelling unit.

Item A is obtained from American Gas Association reports, B from Local Climatological Data,[50] and C, D and E from the Census of Housing.[63] For annual updates of each parameter, contact the NEDS representative in any EPA Regional office.

The resulting natural gas use in therms (one therm = 100,000 BTU) is converted to cubic feet on the basis of natural gas heating value (usually 1000 to 1050 BTU/cubic feet). Residential LPG use is computed by county, using a simpler equation based only on number of dwelling units, heating degree days, and a regional use factor for LPG consumed in cooking and water heating.

Therms of LPG consumed = $(376 + 0.209\ B) \times H + (I \times J) + (K \times L)$

Where: B = annual heating degree days

H = number of occupied dwelling units using LPG for space heating

I = regional average consumption for water heaters, therms

J = number of occupied dwelling units using LPG for water heating

K = regional average consumption for cook stoves, therms

L = number of occupied dwelling units using LPG for cooking

Regional average therms consumed by water heaters and cooking have been estimated by the American Gas Association and are summarized in Reference 48.

Commercial/institutional and industrial use of natural gas and LPG may be estimated by using the same methodology presented for fuel oil use and by obtaining state totals for fuel use from References 64 and 66. However, since natural gas utility companies usually have excellent records of sales data preferably are obtained directly from the gas company. If records are not detailed enough to give county totals, some apportioning may be necessary. If this is the case, the particular institutions and school systems that comprise the commercial/institutional subcategories identified in Section 4.6.1 should be contacted directly. If fuel use totals for these categories can be obtained directly, use of the equations and procedures for commercial/institutional subcategories can be avoided. This step is particularly desirable for a detailed source inventory, since the equations in this section and in Section 4.4.1 do not always yield accurate predictions of fuel use in a small area.

4.6.4 OTHER FUELS

Other fuels which may appear as area source fuels are wood, coke and process gas. Census of Housing[49] data may be used to estimate residential consumption of wood, according to the following equation:[49,63]

$$\text{Residential wood use (tons/yr)} = 0.0017 \times \text{NHUHW} \times \text{HDG} \times \frac{\text{ARPH}}{5.0}$$

Where: NHUHW = Number of housing units heating with wood

HDG = Heating degree days

ARPH = Average rooms per housing unit

Commercial/institutional and industrial wood use is usually ignored, unless surveys of potential sources indicate that wood is consumed by small sources in significant quantities. The most common users of wood as fuel are those wood processing plants that burn wood waste.

Users of coke and process gas can usually be identified only through questionnaire surveys. Neither of these fuels will be used by establishments which are classed as area sources. Process gas use is most common in petroleum refineries, certain chemical processing industries, and iron and steel mills. Coke is consumed mainly by iron and steel mills and foundries.

4.7 OTHER AREA SOURCES

Area sources yet to be discussed are forest fires, slash burning, agricultural burning, structure fires, frost control burners, and natural organic sources. Although they are often intermittent in nature, many of these sources can produce large quantitites of air pollutant emissions. Some of these sources, such as orchard heaters and certain kinds of agricultural burning, are not active during the oxidant season. These area sources are discussed briefly in this section, along with techniques for making crude emission estimates.

4.7.1 FOREST FIRES

Organic emissions from forest fires in certain rural areas can be very large, at least in the short term. Estimates of the quantity and types of growth burned in a given area should be available from the U.S. Forest Services state forestry or agriculture departments, or local fire protection agencies. If local estimates are not available, the U.S. Forest Service annually publishes Wildfire Statistics, which gives the total acreage burned for each state.[67] However, this document does not provide burned acreage by county, so local fire and forestry officials should be consulted for estimates. If sufficient information cannot be obtained from local officials, the state total from Wildfire Statistics should be apportioned to counties according to forest acreage per county. If this information is not available from the appropriate state or local agency, the total acreage burned can be divided equally among counties with significant forest acreage, as shown on state maps.

The determination of tons of growth burned per acre ("fuel loading") is equally important. Local officials should be contacted for this information. The emissions in the study area are then obtained by multiplying the appropriate emission factor in AP-42 by the fuel loading, then multiplying this product, by the amount of forest acreage burned.

Average fuel loadings, emission factors, and estimates of organic emissions from forest fires in the various U.S. Forest Service Regions are presented in Section 11.1 in AP-42.

4.7.2 SLASH BURNING AND AGRICULTURAL FIELD BURNING

Waste from logging operations is often burned under controlled conditions, to reduce the potential fire hazard in forests and to remove brush that can serve as a host for destructive insects. Officials of the U.S. Forest Service or state forestry department should be contacted for estimates of the area burned and quantity of slash per acre. If an estimate of the quantity of slash burned per acre cannot be obtained from other sources, a figure of 75 tons per acre can be used.

Also included in this source category are agricultural fieldburning operations such as stubble burning and burning of land clearing refuse. Little published information is available on this subject, so burning activity estimates must be determined through state agriculture departments or extension services.

Acreage and average fuel loadings should be estimated. The U.S. Soil Conservation Service should be able to provide some of this information. Average fuel loadings and organic emission factors for various wastes are provided in Section 2.4 of AP-42. In some cases, agricultural burning may be reported under residential open burning.

4.7.3 STRUCTURE FIRES

Building fires can also produce short term emissions of organic compounds. The best procedure for determining information for this source category is to contact local fire departments, fire protection associations, or other agencies for an estimate of the number of structural fires in each county during the year. In the absence of such information, assume an average of six fires per 1,000 people each year.[68]

4.7.4 ORCHARD HEATERS

In areas where frost threatens orchards, heaters may be used in cold portions of the growing season. County or state agriculture departments will often have data on the number and types of orchard heaters in use. Data can also be obtained from some of the citrus grove operators in the area. These sources should also be able to furnish the periods of time the units are fired during the year. An estimate should also be obtained of the number of units fired at any one time. These data may be used to determine heater hours of operation. Emission factors for orchard heaters are presented in Chapter 6 of AP-42. Since the use of heaters does not coincide with the usual months of high ozone formation, this source will be of little concern. However, in some locales, fueled heaters may be left in the fields for major portion of the year. This practice will increase evaporative emissions and should be accounted for in the inventory.

References for Chapter 4.0

1. AEROS Manual Series, Volume I: AEROS Overview, EPA-450/2-76-001, U.S. Environmental Protection Agency, Research Triangle Park, NC, February 1976.

2. AEROS Manual Series, Volume II: AEROS User's Manual, EPA-450/2-76-029, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1976.

3. AEROS Manual Series, Volume III: Summary and Retrieval, Second Edition, EPA-450/2-76-009a, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1977.

4. Hydrocarbon Control Strategies for Gasoline Marketing Operations, EPA-450/3-78-017, U.S. Environmental Protection Agency, Research Triangle Park, NC, April 1978.

5. Design Criteria for Stage I Vapor Control Systems for Gasoline Service Stations, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1975.

6. Nonattainment Workshop presented by The Florida Department of Environmental Regulation at the University of Central Florida, Orlando, FL, June 28-29, 1979.

7. W. H. Lamason, "Analysis of Vapor Recovery for the Gasoline Marketing Industry", Pinellas County Department of Environmental Management, Clearwater, FL, December 1979. Unpublished.

8. Highway Statistics, U.S. Department of Transportation, Federal Highway Administration, Washington, DC. Annual publication.

9. 1977 Census of Retail Trade, Bureau of the Census, U.S. Department of Commerce, Washington, DC.

10. Compilation of Air Pollutant Emission Factors, Third Edition and Supplements, AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1977.

11. Emission Inventory for Enforcement of New Source Review Policies, EPA Contract No. 68-01-4148, Pacific Environmental Services, Inc., Santa Monica, CA, April 1979.

12. Florida Oxidant SIP Assistance, Phase I: VOC Emissions Inventory, EPA-904-9/-79-029a, U.S. Environmental Protection Agency, Atlanta, GA, February 1979.

13. Emission Inventories for Urban Airshed Model Application in Tulsa Oklahoma, EPA-450/4-80-021, Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1980.

14. Tampa Bay Photochemical Oxidant Study: Assessment of Anthropogenic Hydrocarbon and Nitrogen Dioxide Emissions in the Tampa Bay Area, EPA-904/9-77-016, U.S. Environmental Protection Agency, Atlanta, GA, September 1978.

15. Volatile Organic Compound Species Data Manual, EPA-450/4-80-015, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1980.

16. Control Techniques for Volatile Organic Emissions from Stationary Sources, EPA-450/2-78-022, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1978.

17. Control of Organic Emissions from Perchloroethylene Dry Cleaning Systems, EPA-450/2-78-050, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1978.

18. W. H. Lamason, "Technical Discussion of Per Capita Emission Factors and National Emissions of Volatile Organic Compounds for Several Area Source Emission Inventory Categories", Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1980. Unpublished.

19. End Use of Solvents Containing Volatile Organic Compounds, EPA-450/3-79-032, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1979.

20. Control of Volatile Organic Emissions from Solvent Metal Cleaning, EPA-450/2-77-022, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1977.

21. County Business Patterns, U.S. Department of Commerce, Bureau of the Census, Washington, DC. Annual publication.

22. Control Techniques Guideline for Architectural Surface Coatings, EPA Contract No. 68-02-2611, Acurex Corporation, Mountain View, CA, February 1979.

23. Emission Inventory/Factor Workshop, Volume II, EPA-450/3-78-042b, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1978.

24. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobile and Light-Duty Trucks, EPA-450/2-77-008, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1977.

25. Air Pollution Engineering Manual, Second Edition, AP-40, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1973. Out of print.

26. Written communication from Bill Lamason, to Chuck Mann, Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1980.

27. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VI: Surface Coating of Miscellaneous Metal Parts and Products, EPA-450/2-78-015, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1978.

28. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VIII: Graphic Arts - Rotogravure and Flexography, EPA-450/2-78-033, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1978.

29. Control of Volatile Organic Compounds from Use of Cutback Asphalt, EPA-450/2-77-037, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1977.

30. Steve Leung, et al., "Air Pollution Emissions Associated with Pesticide Applications in Fresno County", California Air Resources Board Report No. 77-E-02, Eureka Laboratories, Inc., Sacramento, CA, December 1978.

31. F. J. Wiens, A Methodology for Reactive Organic Gas Emissions Assessment of Pesticide Usage in California, (Draft Interim Report), California Air Resources Board, 1977.

32. Development of Questionnaires for Various Emission Inventory Uses, EPA-450/3-78-122, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1979.

33. Official Airline Guide, Rueben H. Donnelly Corporation, Oak Brook, IL. Semi-monthly publication.

34. Airport Activity Statistics for Certified Route Air Carriers, Federal Aviation Administration, U.S. Department of Transportation, Washington, DC. Annual publication.

35. Air Pollutant Emission Factors for Military and Civil Aircraft, EPA-450/3-78-117, U.S. Environmental Protection Agency, Research Triangle Park, NC, October 1978.

36. FAA Air Traffic Activity, Federal Aviation Administration, U.S. Department of Transportation, Washington, DC, 1970.

37. Military Air Traffic Activity Report, Federal Aviation Administration, U.S. Department of Transportation, Washington, DC, 1970.

38. Census of U.S. Civil Aircraft, Federal Aviation Administration, U.S. Department of Transportation, Washington, DC, 1970.

39. Mineral Industry Surveys, "Sales of Fuel Oil and Kerosene", Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual publication.

40. Census of Population, Bureau of the Census, U.S. Department of Commerce, Washington, DC. Decennial publication.

41. Minerals Yearbooks, Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual publication.

42. Boating: A Statistical Report on America's Top Family Sport, The National Association of Engine and Boat Manufacturers, Greenwich, CT. Annual publication.

43. Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines, APTD-1490 through APTD-1496, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1972-1974.

44. Area Management Reports, GE-20 Series, Corps of Engineers, U.S. Department of the Army, New Orleans, LA, 1970.

45. Waterborne Commerce of the United States, Corps of Engineers, U.S. Department of the Army, New Orleans, LA, 1970.

46. J.R. Pearson, "Ships as Sources of Emissions", Presented at the Annual Meeting of the Pacific Northwest International Section of the Air Pollution Control Association, Portland, OR, 1969.

47. Census of Agriculture, Bureau of the Census, U.S. Department of Commerce, Washington, DC, 1969.

48. 1978 National Emissions Data System (NEDS) Fuel Use Report, Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, NC, October 1980. Unpublished.

49. 1970 Census of Housing, "Detailed Housing Characteristics", HC-B Series, Bureau of the Census, U.S. Department of Commerce, Washington DC, 1970.

50. Local Climatological Data: Annual Summary with Comparative Data, U.S. Department of Commerce, Washington, DC. Annual publication.

51. R.J Black, et al., The National Solid Waste Survey: An Interm Report, U.S. Public Health Service, Rockville, MD, 1968.

52. National Survey of Community Solid Waste Practices: Interim Report, U.S. Department of Health, Education and Welfare, Cincinnati, OH, 1968.

53. National Survey of Community Solid Waste Practices: Preliminary Data Analysis, U.S. Department of Health, Education and Welfare, Cincinnati, OH, 1968.

54. Ronald J. Brinkerhoff, "Inventory of Intermediate Size Incinerators in the United States - 1972", Pollution Engineering, 5(11):33-38, November 1973.

55. OAQPS Data File of Nationwide Emissions, 1971, Monitoring and Data Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1973. Unpublished report.

56. Standard Industrial Classification Manual, Office of Management and Budget, Washington, DC, 1972.

57. "Steam Electric Plant Air and Water Quality Control Data for the Year Ended December 31, 19__", Federal Power Commission Form 67.

58. "Natural Gas Companies Annual Report", Federal Power Commission Forms 2 and 2-A.

59. 1977 Census of Manufacturers: Subject Series, "Fuels and Electric Consumed", U.S. Department of Commerce, Washington, DC, 1977.

60. Development of a Methodology To Allocate Liquid Fossil Fuel Consumption by County. EPA-450/3-74-021, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1974.

61. Fuel Trades Fact Book, New England Fuel Institute, Boston, MA, 1973.

62. Coal - Bituminous and Lignite, Bureau of Mines, U.S. Department of Interior, Washington, DC, 1970.

63. 1970 Census of Housing, "Advance Report", Series HC-(V1), Bureau of the Census, U.S. Department of Commerce, Washington, DC, 1971.

64. Mineral Industry Surveys, "Sales of LPG and Ethane", Bureau of Mines, U.S. Department of the Interior, Washington, DC. Annual publication.

65. Mineral Industry Surveys, "Natural Gas Production and Consumption", Bureau of Mines, U.S. Department of the Interior, Washington, DC, 1970.

66. G. Ozolins and R. Smith, *A Rapid Survey Technique of Estimating Community Air Pollution Emissions*, 999-AP-29, U.S. Department of Health, Education and Welfare, Cincinnati, OH, October 1966.

67. *Wildfire Statistics*, Forest Service, U.S. Department of Agriculture, Washington, DC. Annual publication.

68. *Statistical Abstract of the United States*, Bureau of the Census, U.S. Department of Commerce, Washington, DC. Annual publication.

5.0 INVENTORY METHODS FOR HIGHWAY VEHICLES

Highway vehicle emissions can be inventoried with data obtained from the transportation planning process which is required in larger urban areas. EPA's Office of Transportation and Land Use Policy (OTLUP) is responsible for EPA policy on conducting highway vehicle emission inventories. Guidance is under preparation and will become Chapter 5 of this report. In the interim, for further information contact:

Director
Office of Transportation and
Land Use Policy
ANR-443
401 M Street, SW
Washington, DC 20460

6.0 EMISSION CALCULATIONS

After planning and data collection, the third basic step in the inventory is the calculation of emissions. This involves (1) an analysis of the point and area source data collected by the procedures outlined in the proceeding two chapters and (2) the development of emissions estimates for each source. In some cases, test data will be supplied by the source. However, in most instances the agency will have to compute emissions using emission factors or material balance considerations. The following three sections discuss the making of emission estimates based on source test data, material balances, and emission factors.

In cases where no data have been obtained for certain point sources, the agency may choose to "scale up" the inventory to account for these missing sources indirectly rather than spend extra effort in an attempt to get the necessary information directly from each source. Techniques for accomplishing this are presented in Section 6.4.

Because reactive, rather than total, VOC emissions are needed in inventories used in ozone control programs, nonreactive VOC must be excluded from the emission totals for each source category. Section 6.5 of this chapter presents procedures for excluding nonreactive VOC from the inventory.

Section 6.6 discusses the seasonal adjustment of annual emission inventories. Seasonally adjusted inventories are of interest because higher ozone concentrations are generally associated with the warmer months of the year, and because VOC emissions from some sources vary seasonally. Thus, since most inventories are developed for an annual period, seasonal adjustment may be desirable to emphasize the relative importance of VOC emissions during the warmer months constituting the ozone season.

A necessary element in any control program is the projection inventory showing anticipated emissions at some future date(s). Generally, at least two such projection inventories are required: baseline and control strategy. More may be required if multiple strategies or alternate growth scenarios are to be evaluated. The calculation of projection year emissions is discussed in Section 6.7.

6.1 SOURCE TEST DATA

In many cases, the most accurate method of estimating a source's emissions is to use test data obtained by the agency or supplied by the plant itself. The use of source test data reduces the number of assumptions that need be made by the agency regarding the applicability of generalized emission factors, control device efficiencies, equipment variations, or fuel characteristics. A single source test or series of tests, taken over a sufficiently long time to produce results representative of conditions that would prevail during the time period inventoried, will normally account for most of these variables. The most nearly complete type of source testing is continuous monitoring.

Most source test reports summarize emissions for each pollutant by expressing them in terms of (1) a mass loading rate (weight of pollutant emitted per unit time), (2) an emission factor (weight of pollutant emitted per unit of process activity), or (3) in terms of a flue gas concentration (weight or number of moles of pollutant per some weight or volume of flue gas). Generally, when a mass loading rate or emission factor is provided, the resulting emission estimates can be easily calculated. For example, if the average VOC emission rate for the time period tested was 12 lbs/hr, and the source operated for 16 hrs/day, 350 days/year, daily emissions would be 12 x 16, or 192 lbs, and the annual emissions would be 192 x 350, or 67,200 lbs (34 tons). Or, if an emission factor of 5 lbs of VOC per ton of product was given, and the plant produced 160 tons of product per day for 200 days per year, annual emissions would be 5 x 160 x 200, or 160,000 lbs (80 tons).

If the source test results are expressed in terms of VOC concentrations, the emission calculations are more detailed. As an example, assume that volatile organic compound emissions are expressed as parts per million, as shown in Table 6.1-1. In this case, the concentration measurements and the flow rate measurements are used to obtain mass loading rates. (A formula for determining mass loading rates is shown as part of the calculations in Table 6.1-1.) Note that in this example, the results are expressed as methane, and a molecular weight of 16 lbs/lb-mole is used in the mass loading rate formula. If the concentration was expressed in terms of another organic reference compound, the appropriate molecular weight would be used. Upon determining the mass loading rate (0.3 lbs/hr, in this example), this rate can be divided by the production rate at the time of testing to yield an emission factor of 0.1 lbs VOC emitted per ton of production. After averaging the individual mass loading rates and emission factors determined for all runs of the source test, the resulting average mass loading rate or emission factor can be multiplied by the annual operating time or annual production, respectively, to determine annual emissions. Emissions can be calculated similarly for other time periods.

Two points should be noted when using source test data to calculate emissions. First, because source tests are generally only conducted over several hours or days, at most, caution is urged when using these data to estimate emissions over longer time intervals or for conditions different from those under which the tests were performed. Adjustments may be needed to account for differing conditions. Second, a source test supplied by a plant may not adequately describing a given facility's annual or seasonal operating pattern. In cases where such data are not included in the test reports, an operating rate will have to be obtained in order to make reliable annual or seasonal emission estimates. This is best done by contacting the plant and obtaining operating information for the period the test was conducted. Such information could be obtained from questionnaire data but may not be as accurate.

Source Test Results

Run Number	1	2	3
Date	8-5-71	8-6-71	8-7-71
Stack flow rate (scfm)	9840	8510	10290
% Excess air	225	227	366
CO emissions (ppm, by volume)	2.5	6.4	4.6
VOC emissions (ppm, by volume, as CH_4)	11.9	6.8	10.9
Process Conditions			
Production rate (tons/hour)	3.0	3.2	3.1

Calculation of VOC Emissions

Conversion formula:

$$\text{lb VOC/hr} = 1.58 \times M \times 10^{-7} \times \text{ppm} \times \text{SCFM}$$

Where M = molecular weight of reference VOC

Calculation for Run 1:

$$\text{Mass loading rate} = 1.58 \times 16 \times 10^{-7} \times 11.9 \times 9840 = 0.3 \text{ lb/hr}$$

$$\text{Emission factor} = 0.3 \text{ lb/hr} \times 1 \text{ hr/3 tons production}$$
$$= 0.1 \text{ lb VOC/ton production}$$

Table 6.1-1. Example Source Test Data and Emission Calculations

6.2 MATERIAL BALANCE

If source test results are not available, the agency can, in some cases, use material balance considerations to estimate emissions. In fact, for some sources, a material balance is the only practical method to estimate VOC emissions accurately. Source testing of low level, intermittent, or fugitive VOC exhaust streams can be very difficult and costly in many instances. Emissions from solvent evaporation sources are most commonly determined by the use of material balances.

Use of a material balance involves the examination of a process to determine if emissions can be estimated solely on knowledge of specific operating parameters and material compositions. Although the material balance is a valuable tool in estimating emissions from many sources, its use requires that a measure of the material being "balanced" be known at each point throughout the process. If such knowledge is not available, and is therefore assumed, serious errors may result.

In the VOC emission inventory, a material balance is generally used to estimate emissions from solvent evaporation sources. This technique is equally applicable to both point and area sources. The simplest form of material balance is to assume that all solvent consumed by a source process will be evaporated during that process. For instance, the assumption is reasonable that, during many surface coating operations, all of the solvent in the coating evaporates to the atmosphere during the drying process. In such cases, emissions simply are equal to the amount of solvent applied in the surface coating (and added thinners) as a function of time. As another example, consider a dry cleaning plant that uses Stoddard solvent as the cleaning agent. To estimate emissions, the agency needs only to elicit from each plant the amount of solvent purchased during the time interval of concern, because emissions are assumed equal to the quantity of solvent purchased.

The assumption that makeup solvent equals emissions also holds in certain more complicated situations. If a nondestructive control device such as a condenser or adsorber is employed, this assumption is valid to the extent that the captured solvent is returned to the process. Similarly, if waste solvent reclamation is practiced a plant, by distillation or "boildown", this assumption will be applicable. Both of these practices simply reduce the makeup solvent requirements of an operation and commensurately, the quantity of solvent lost to the atmosphere.

In the above discussion, the material balance is simplified because of the assumption that all of the consumed solvent evaporates and is emitted to the atmosphere. Situations exist where such an assumption is not always reasonable. For example, if a destructive control device such as an afterburner, incinerator, or catalytic oxidation unit is employed on the process exhaust, any VOC emissions will be either destroyed or so altered that one could not reasonably assume, without testing the exhaust downstream of the device, the characteristics and quantities of any remaining VOC material. As another example, degreasing emissions will not equal solvent consumption if the waste solvent is sold to a commercial reprocessor. In such a situation, emissions will be the difference of solvent consumed and solvent in the waste sent to the reprocessor. As still another example, some fraction of the diluent used to liquify cutback asphalt is believed not to evaporate after application, but rather, it is retained in the pavement. The above examples show that, if one assumes total evaporation of all consumed solvent, overestimation of emissions will result in many cases.

Several other situations can complicate the material balance. First, not all of the solvent losses from certain operations such as drycleaning or degreasing occur at the plant site. Significant quantities of solvent may be evaporated, instead, from the waste solvent disposal site, unless the waste solvent is incinerated or disposed of in a manner, such as deep well injection, that precludes subsequent evaporation to the atmosphere. Generally, one can assume that much of the solvent sent to disposal sites will evaporate. The fact that some solvent associated with various operations evaporates at the point of disposal rather than at the point of use should be determined, as these losses may occur outside of the area covered by the inventory.

Material balances cannot be employed in some evaporation processes because the amount of material lost is too small to be determined accurately by conventional measurement procedures. As an example, applying material balances to petroleum product storage tanks is not generally feasible, because the breathing and working losses are too small, relative to the total average capacity or throughput, to be determined readily from changes in the amount of material stored in each tank. In these cases, AP-42 emission factors developed by special procedures, will have to be applied.[1]

6.3 EMISSION FACTORS

One of the most useful tools available for estimating emissions from both point and area sources is the emission factor. An emission factor is an estimate of the quantity of pollutant released to the atmosphere as a result of some activity, such as combustion or industrial production, divided by the level of that activity. In most cases emission factors are expressed simply as a single number, with the underlying assumption being that a linear relationship exists between emissions and the specified activity level over the probable range of application. Empirical formulas have been developed for several source categories that allow the agency to base its emission estimates on a number of variables instead of just one. The most important VOC emitters for which a number of variables are needed to calculate emissions are highway vehicles and petroleum product storage and handling operations. As a rule, the most reliable emission factors are those based on numerous and representative source tests or on accurate material balances.

The use of an emission factor to estimate VOC emissions from a source necessitates that the agency have complete source and control device information. In many cases, including most combustion sources, the emission calculation merely involves the multiplication of the appropriate emission factor by the source activity, such as fuel combustion, for the time interval in question. If a control device is in place, an adjustment factor equal to

(1-fractional control device efficiency) should be multiplied by the uncontrolled emission estimate to account for the effect of the device. In AP-42, as in most cases, emission factors typically represent uncontrolled emissions or emissions before any control device.

When empirical formulas are available, more detailed computations may be needed to estimate emissions. As mentioned above, highway vehicles and petroleum product handling and storage operations are sources for which a number of variables must be considered in the emission calculations. The following is a sample calculation for an external floating roof tank.[2]

Problem

Estimate the total annual evaporative loss, in pounds per year, given the following information:

Tank description: Welded, external floating roof tank in good condition; mechanical shoe primary seal; 100 ft. diameter; tank shell painted aluminum color.

Stored product: Motor gasoline; Reid vapor pressure, 10 psi; 6.1 lbs/gal liquid stock density; no vapor or liquid composition given; 1.5 million bbl/yr average annual throughput.

Ambient conditions: 60°F average annual ambient temperature; 10 mi/hr average annual wind speed at tank site; assume 14.7 psia atmospheric pressure.

Solution

Standing Storage Loss - Calculate the standing storage loss from Equation 6.3-1 below:

$$L_s\text{(lb/yr)} = K_s V^n P^* D M_v K_C \qquad \text{(Equation 6.3-1)}$$

The variables in Equation 6.3-1 can be determined as follows:

K_s = 1.2 (from Table 6.3-1, for a welded tank with a mechanical shoe primary seal).

n = 1.5 (from Table 6.3-1, for a welded tank with a mechanical shoe primary seal).

V = 10 mi/hr (given).

$V_n = (10)^{1.5} = 32.$

T_a = 60°F (given).

T_s = 62.5°F (from Table 6.3-2, for an aluminum color tank in good condition and T_a = 60°F).

RVP = 10 psi (given).

P = 5.4 psia (from Figure 6.3-1, for 10 psi Reid vapor pressure gasoline and T_s = 62.5°F).

P_a = 14.7 psia (assumed).

$$P^* = \frac{\frac{5.4}{14.7}}{\left[1 + \left(1 - \frac{5.4}{14.7}\right)^{0.5}\right]^2} = 0.114$$

D = 100 ft (given).

M_v = 64 lbs/lb-mole (typical value for gasoline).

K_c = 1.0 (given).

W_v = 5.1 lbs/gal (approximated assuming $W_v = 0.08\ M_V$).

To calculate standing storage loss in lb/yr, multiply the the K_s, V^n, P^*, D, M_v, and K_c values, as in Equation 6.3-1.

$$L_s(\text{lbs/yr}) = (1.2)(32)(0.114)(100)(64)(1.0) = 28{,}000 \text{ lbs/yr}$$

Withdrawal loss - Calculate the withdrawal loss from Equation 6.3-2 below:

$$L_w(\text{lb/yr}) = (0.943)\ \frac{QCW_1}{D} \qquad \text{(Equation 6.3-2)}$$

The variables in Equation 6.3-2 can be determined as follows:

Q = 1.5 x 10^6 bbl/yr (given).

C = 0.0015 bbl/1000 ft^2 (from Table 6.3-3, for gasoline in a steel tank with light rust).

W_ℓ = 6.1 lbs/gal (given).

D = 100 ft (given).

To calculate withdrawal loss in lb/yr, use Equation 6.3-2.

$$L_w(\text{lb/yr}) = \frac{(0.943)(1.5 \times 10^6)(0.0015)(6.1)}{100} = 129 \text{ lbs/yr}$$

Total Loss - Calculate the total loss from Equation 6.3.3 below:

$$L_t(\text{lb/yr}) = L_s(\text{lb/yr}) + L_w(\text{lb/yr}) \qquad \text{(Equation 6.3-3)}$$

$$L_t(\text{lb/yr}) = (28{,}000) + (129) = 28{,}129 \text{ lb/yr}$$

The discussion on emission factors thus far has dealt with "activity level emission factors", factors that relate emissions with some level of production or capacity. This type of emission factor is generally the most accurate, as it physically relates the most appropriate process parameters with emissions. Another type of factor that can be of some use is the emissions-per-employee factor. As briefly discussed in Chapters 3 and 4,

Table 6.3-1. Summary of Average Seal Factors (K_s) and Wind Speed Exponents (n)

TANK/SEAL TYPE	K_s	n
WELDED TANKS		
1. Mechanical shoe seal		
a. Primary only	1.2	1.5
b. Shoe-mounted secondary	0.8	1.2
c. Rim-mounted secondary	0.2	1.0
2. Liquid-mounted resilient filled seal		
a. Primary only	1.1	1.0
b. Weather shield	0.8	0.9
c. Rim-mounted secondary	0.7	0.4
3. Vapor-mounted resilient filled seal		
a. Primary only	1.2	2.3
b. Weather shield	0.9	2.2
c. Rim-mounted secondary	0.2	2.6
RIVETED TANKS		
a. Mechanical shoe primary only	1.3	1.5
b. Shoe-mounted secondary	1.4	1.2
c. Rim-mounted secondary	0.2	1.6

Table 6.3-2. Average Annual Stock Storage Temperature (T_s) as a Function of Tank Paint Color

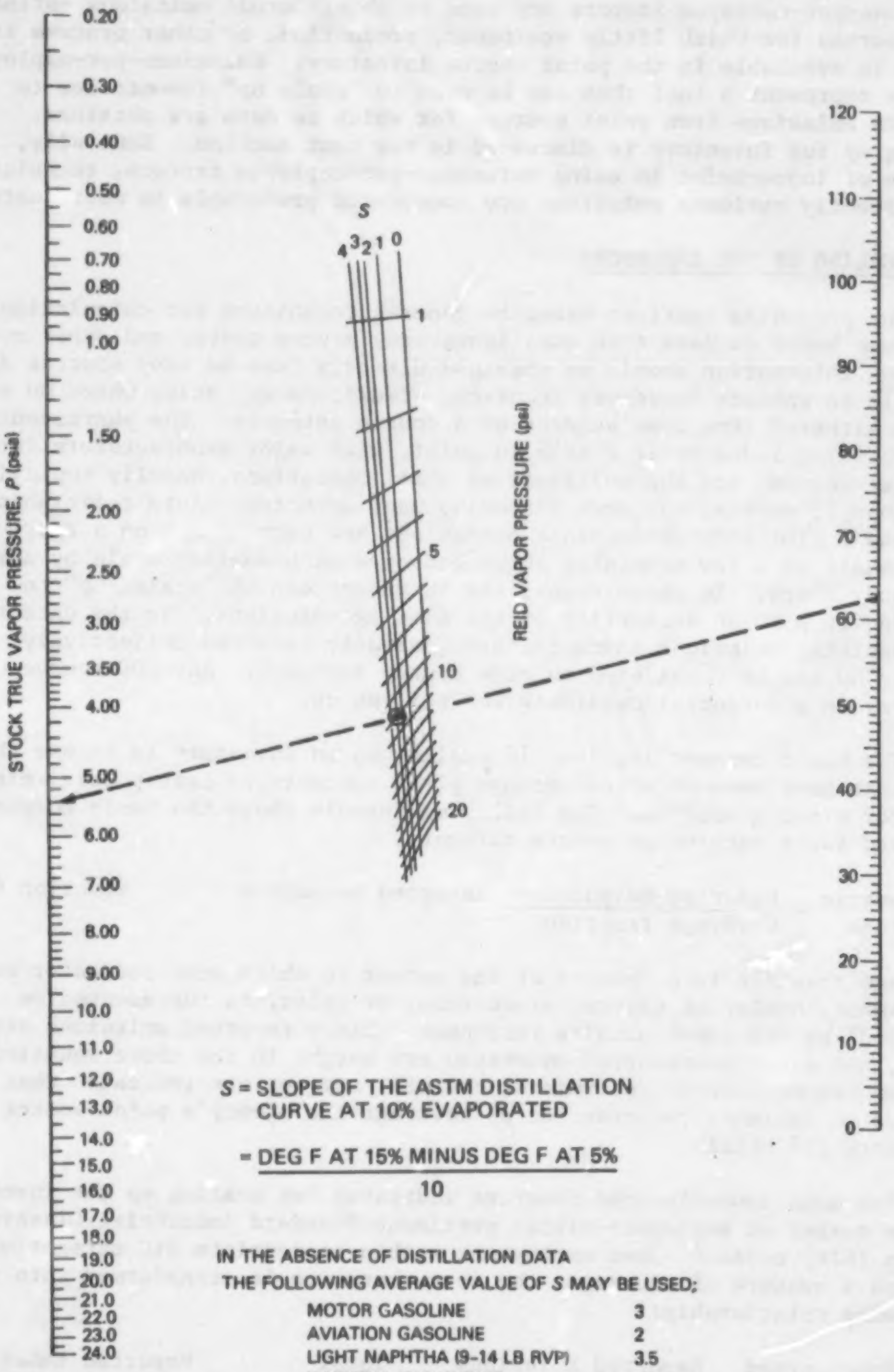
TANK COLOR	AVERAGE ANNUAL STOCK STORAGE TEMPERATURE, T_s (F)
White	$T_a{}^* + 0$
Aluminum	$T_a + 2.5$
Gray	$T_a + 3.5$
Black	$T_a + 5.0$

*T_a is average annual ambient temperature in degrees Farenheit.

SOURCE: *Evaporation Loss from Fixed Roof Tanks*, Bulletin 2518, American Petroleum Institute, Washington, DC, June 1962.

Table 6.3-3. Average Clingage Factors, C(bbl/1000 ft^2)

	SHELL CONDITION		
PRODUCT	LIGHT RUST	DENSE RUST	GUNITE-LINED
Gasoline	0.0015	0.0075	0.15
Crude Oil	0.0060	0.030	0.60



S = SLOPE OF THE ASTM DISTILLATION CURVE AT 10% EVAPORATED

$$= \frac{\text{DEG F AT 15\% MINUS DEG F AT 5\%}}{10}$$

IN THE ABSENCE OF DISTILLATION DATA THE FOLLOWING AVERAGE VALUE OF *S* MAY BE USED;

MOTOR GASOLINE	3
AVIATION GASOLINE	2
LIGHT NAPHTHA (9–14 LB RVP)	3.5
NAPHTHA (2–8 LB RVP)	2.5

NOTE: Dashed line illustrates sample problem for RVP = 10 pounds per square inch, gasoline stock ($S = 3$), and $T_s = 62.5$ F.

SOURCE: Nomograph drawn from the data of the National Bureau of Standards.

Figure 6.3-1. True Vapor Pressure (*P*) of Refined Petroleum Stocks (1 psi to 20 psi RVP).

emissions-per-employee factors are used to obtain crude emissions estimates from sources for which little equipment, production, or other process information is available in the point source inventory. Emissions-per-employee factors represent a tool that can be used to "scale up" inventories to estimate emissions from point sources for which no data are obtained. Scaling up for inventory is discussed in the next section. Generally, because of imprecision in using emissions-per-employee factors, techniques that directly estimate emissions are considered preferable in most instances.

6.4 SCALING UP THE INVENTORY

The preceding sections describe general techniques for calculating emissions based on data from questionnaries, source tests, and other methods. Although information should be obtained directly from as many sources as possible to enhance inventory accuracy, situations may arise where no data can be gathered from some segment of a source category. The pharmaceutical manufacturing industry is a case in point, with major manufacturers included as point sources and the multitude of small operations, usually employing less than 25 people, not even listed by many agencies. Auto refinishing presents a similar problem since operations are carried out on a fairly large scale by a few specialty shops and on a much smaller scale by numerous auto body shops. In these cases, the inventory can be "scaled up" to provide for a rough accounting of the missing emissions. To the extent that the resulting emissions estimates are generally reported collectively, scaling up can be considered an area source approach. Any VOC source category is a potential candidate for scaling up.

The basic concept involved in scaling up an inventory is to use the data that have been received through plant contacts to extrapolate emission data for missing sources. The following formula shows the basic computation involved for a particular source category.

$$\text{Nonreported emissions} = \frac{\text{Reported Emissions}}{\text{Coverage Fraction}} - \text{Reported Emissions} \qquad \text{(Equation 6.4-1)}$$

Coverage fraction is a measure of the extent to which some indicator such as employment, number of plants, production, or sales, is represented or "covered" by the questionnaire responses. Since reported emissions are known, and since nonreported emissions are sought in the above equation, the problem becomes one of determining the most appropriate indicator that can be used to estimate the fraction of coverage the agency's point source inventory did obtain.

The most commonly used coverage indicator for scaling up the inventory is the number of employees within pertinent Standard Industrial Classification (SIC) codes.[3] When employment within appropriate SIC categories is used as a measure of coverage, the above equation is transformed into the following relationship:

$$\text{Nonreported emissions} = \frac{\text{Reported Emissions}}{\text{Reported Employment}} \times \text{Total Employment} - \text{Reported Emissions} \qquad \text{(Equation 6.4-2)}$$

In Equation 6.4-2, the ratio of reported emissions to reported employment is an emissions-per-employee factor. Equation 6.4-2 can be used in either of two ways to estimate missing point source emissions.

The recommended way to use Equation 6.4-2 is to derive values of both reported emissions and reported employment for each SIC category directly from the local point source data base. One advantage of this approach is that the resulting emissions-per-employee factors are tailored to the area of concern. One potential disadvantage is that the resulting factors, if based only on point source data, may not be representative of the smaller sources to which these factors will generally be applied. An example of this direct approach is given:

Example: Consider the situation of an area wherein five plants in SIC 3069 are coded as point sources, having combined annual emissions of 685 TPY of VOC. Based on employment data coded on the point source forms (or determined by plant contacts), these five sources employ 3,250 workers. According to County Business Patterns, 3529 persons are employed in SIC 3069 within the same area. Nonreported VOC emissions in SIC 3069 for this county can thus be calculated as:

$$\text{Nonreported emissions} = \left[\frac{685\ \text{TPY}}{3244\ \text{employees}}\right] \times 3808\ \text{employees} - 685\ \text{TPY}$$

$$= 119\ \text{TPY}$$

Hence, in this example, total emissions for the county in SIC 3069 would be estimated as 804 TPY. VOC emissions for the other SIC categories would be scaled up similarly. Note that in the above equation, the figure (685/3244) is an emission-per-employee factor, equal to 0.211 ton/yr-employee.

The alternative to using values of reported emissions and employment directly from the local point source inventory is to apply emissions-per-employee factors that have been developed from inventory data in other areas. Examples of where this has been done are given in References 4 through 6. Ranges of emissions-per-employee factors for the more important industrial VOC sources are shown in Table 3.1-1 in Chapter 3. If, in the above example, an emissions-per-employee factor of 0.21 had been used from Table 3.1-1, Equation 6.4-2 then becomes:

$$\text{Nonreported emissions} = (0.21\ \text{TPY/employee} \times 3808\ \text{employees}) - 685\ \text{TPY}$$

$$= 115\ \text{TPY}$$

One distinct advantage of using "borrowed" emissions-per-employee factors is that reported employment is not needed, which means that the technique can be used even where employment data are not collected for each point source. However, few emissions-per-employee factors are available in the literature, and an agency generally does not know what specific operations are covered by published factors. Hence, since the applicablility of published emissions-per-employee factors to an agency inventory may be questionable, the agency should try to develop emissions-per-employee factors tailored to its own particular area. Moreover, these factors should be developed at the four digit level to prevent misapplication to employees not engaged in VOC emitting operations.

Regardless of whether locally developed or published emissions-per-employee factors are used, estimates of total employment within each industrial category are needed in order to use Equation 6.4-2. The most convenient source of employment is the U.S. Department of Commerce's publication County Business Patterns which summarizes employment, generally by county, for SIC categories at the 2, 3, and 4 digit level.[7] Other sources of industrial listings include state departments of labor/industry and various industrial directories. In some cases, employment in various categories will be determined as part of the ongoing transportation planning process in larger urban areas. The agency should determine which of these sources is most current and appropriate for estimating industrial coverage within its jurisdiction.

Extreme caution should be exercised when considering the emissions-per-employee factor method. Any emissions-per-employee ratio approach is necessarily somewhat crude, and should not be used to estimate the bulk of VOC emissions in an area. If the scaled up emission totals determined by this approach are significantly greater than the point source totals for the corresponding SIC categories, consideration should be given to expending more effort in the point source inventory, particularly for the more important source categories. Care should also be taken that any scaling up does not result in some inadvertent double accounting of emissions. Some portion of the resulting scaled up emission totals already may be accounted for by per capita emission factors or even by the application of other emission-per-employee factors to the same source category.

6.5 EXCLUDING NONREACTIVE VOC FROM EMISSION TOTALS:

As was discussed in Section 2.2.6, a number of VOCs are considered photochemically nonreactive and thus should be excluded from the inventory used in the agency's ozone control program.[8,9] These nonreactive compounds are listed below:

Methane
Ethane
1,1,1-Trichloroethane (methyl chloroform)
Methylene chloride
Trichlorofluoromethane (CFC 11)
Dichlorodifluoromethane (CFC 12)
Chlorodifluoromethane (CFC 22)
Trifluoromethane (FC 23)
Trichlorotrifluoroethane (CFC 113)
Dichlorotetrafluoroethane (CFC 114)
Chloropentafluoroethane (CFC 115)

All of the above compounds, with the exception of methane and ethane, are halogenated organics. Halogenated organics find principal applications as metal and fabric cleaners, refrigerants, and propellants in aerosol products.

A major industrial category employing these halogenated compounds is degreasing, which is discussed in Section 4.3.2. To exclude these nonreactive VOC from the degreasing emission totals, the agency should elicit information on the particular type of solvent used in each degreasing unit. If information is obtained on the questionnaire or during the plant contact, the agency should experience little difficulty excluding emissions of these nonreactive solvents from the resulting emission totals.

More difficulty is encountered when excluding nonreactive VOC from degreasers covered in the area source inventory, because numerous solvents will comprise the emission total. Several alternatives are available for determining an average degreasing solvent mix for area sources. One way is simply to summarize the solvent usage from the point source inventory and to apply the resultant mix to the area source total. Another alternative would be to conduct a brief survey of small degreasing facilities in the area. If either of these approaches is followed, a separate solvent mix should be determined for cold cleaning units and vapor degreasers and applied accordingly to the emission total for each degreasing category. If these procedures prove unworkable, nationwide data may be utilized. As an average, 75 percent of the solvent used in small cold cleaners is reactive, whereas only about 60 percent of the solvent used in vapor degreasing is reactive.[10] Because these averages may vary considerably from area to area and with time, local solvent mix data should be used, if reasonably available.

A small percentage of dry cleaning establishments use trichlorotrifluoroethane (fluorocarbon 113) as a fabric cleaning solvent. Information on the type of solvent used at each dry cleaning plant should be obtained during plant contacts so that fluorocarbon 113 emissions could be directly excluded. If dry cleaners are treated as area sources in the inventory, local survey results or other data will be needed to determine the fraction of total cleaning solvent in the area that is fluorocarbon 113. Nationwide, fluorocarbon 113 is only used in about 5 percent of the coin operated units, and accounts for only about 0.4 percent of total annual dry cleaning solvent consumption.[11] Hence, in most situations, little error is involved if all dry cleaning solvent is assumed to consist of perchloroethylene and petroleum solvents.

Refrigerants represent the largest application for fluorocarbons. The major fluorocarbons used in refrigerators, freezers and air conditioners are fluorocarbon 11, 12 and 22.[12] Because these are all nonreactive, emissions associated with refrigerant use need not be included in the VOC inventory used in an ozone control program.

Until the ozone layer controversy, the largest percentage of fluorocarbons were used as aerosol propellants. Methylene chloride is also used as a propellant in aerosol products. Aerosol propellant use can be accounted for in the VOC inventory by using the per capita factor suggested in Section 4.3.7. Much of the propellent used in aerosol products is comprised of nonreactive halogenates, and should not be included in the inventory.[12,13]

The agency should be aware of several other end uses of these halogenated compounds that may be encountered in a VOC inventory. The bulk of all trichloroethane is used for metal cleaning, but a small fraction is found in polishes and waxes. This use is also discussed in Section 4.3.7. Similarly, methylene chloride is not only used for degreasing and in aerosol products, but is also used in paint removal operations and in the pharmaceutical industry. Likewise, fluorocarbons are also used as blowing agents to increase the insulation properties of urethane foams and used in plastic materials. To the extent that emissions from these various processes are known to be comprised of nonreactive VOC, they should be excluded from the inventory.[12,13]

All combustion sources emit methane and lesser amounts of ethane. Since source test data are generally not available for most combustion sources, to estimate the nonreactive fraction the agency will have to apply typical VOC species profiles to each source category. VOC profiles for many source categories are shown in Reference 14. An example VOC profile from this reference is shown in Table 6.5-1, representing industrial, natural gas fired, reciprocating internal combustion engines. Based on Table 6.5-1, 76 percent and 10 percent by weight of all VOC emitted from this type of combustion are methane and ethane, respectively. All of the other compounds are photochemically reactive. Hence, total emissions from this source would have to be multiplied by the quantity [1-(.76 + .10)], or 0.14, to determine the fraction that is reactive and that should be included in the inventory. Methane and ethane emissions can be excluded from other sources in the same manner. In general, no halogenated organics are emitted from combustion processes, hence, methane and ethane are the only two compounds to be considered for exclusion from the VOC inventory when dealing with combustion sources.

6.6 SEASONAL ADJUSTMENT OF THE ANNUAL INVENTORY

Most VOC emission inventories have traditionally contained estimates of annual emissions. Hence, all procedures, emission factors, correction factors, and activity levels employed in the inventory have been developed to represent annual average conditions. However, because high photochemical ozone levels are generally associated with the warmer months of the year, and because VOC emissions from some sources vary seasonally, the relative importance of VOC emissions should be determined during the warmer months constituting the ozone season.

A seasonally adjusted VOC inventory can be developed in various ways. One approach is to compile a separate inventory expressly for a typical day during the ozone season. This could entail the development of specific questionnaires, methodologies, seasonal emission factors, and correction factors, for that typical day. This approach, while representing the ideal, would require more resources than are commonly available, especially if an annual inventory has already been compiled.

A more reasonable alternative is to use the existing annual inventory but, for the most important source categories, to adjust those variables affecting emissions to reflect conditions that prevail during the ozone season. This approach provides much of the seasonal specificity of the "typical day" inventory and does so with a minimal amount of effort. Because adjusting the existing annual inventory is preferable in many cases to developing an additional ozone season specific inventory, techniques for making such an adjustment are described below.

DECEMBER 14, 1978 Table 6.5-1

INTERNAL COMBUSTION ENGINE, INDUSTRIAL
NATURAL GAS, RECIPROCATING
DATA CONFIDENCE LEVEL: III

CONTROL DEVICE: NONE
PROCESS MODIFICATION: NONE
KVB PROFILE KEY 0010

LINE NO.	SAROAD CODE	CHEMICAL NAME	MOLECULAR WEIGHT	PERCENT WEIGHT	PERCENT VOLUME	CHEMICAL CLASSIFICATION
1	43204	PROPANE	44.09	10.00	4.20	1 PARAFFIN
2	43212	N-BUTANE	58.12	1.00	.31	1 PARAFFIN
3	43214	ISOBUTANE	58.12	1.00	.31	1 PARAFFIN
4	43203	ETHYLENE	28.05	1.00	.67	2 OLEFIN
5	43502	FORMALDEHYDE	30.03	1.00	.61	4 CARBONYL
6	43201	METHANE	16.04	76.00	87.72	6 METHANE
7	43202	ETHANE	30.07	10.00	6.17	7 NON-REACTIVE
		TOTAL		100.00	99.99	
		3 COMPOUNDS OF CLASSIFICATION 1	45.89	12.00	4.82	
		1 COMPOUNDS OF CLASSIFICATION 2	28.05	1.00	.67	
		0 COMPOUNDS OF CLASSIFICATION 3	.00	.00	.00	
		1 COMPOUNDS OF CLASSIFICATION 4	30.03	1.00	.61	
		0 COMPOUNDS OF CLASSIFICATION 5	.00	.00	.00	
		1 COMPOUNDS OF CLASSIFICATION 6	16.04	76.00	87.72	
		1 COMPOUNDS OF CLASSIFICATION 7	30.07	10.00	6.17	
		7 COMPOUND COMPOSITE	18.51	100.00	99.99	

NOTES:
A. METHOD: CALCULATIONS FROM COMPOSITE SURVEY DATA GC-MS ANALYSIS OF SAMPLING TRAIN CATCH
B. REFERENCES: KVB TEST DATA, AP-42 SECTION 3.3
C. APPLICABLE SCC CATEGORIES: 2-02-002-02

The basic procedure for adjusting the annual inventory involves identifying those variables that influence emissions seasonally and substituting appropriate values that reflect conditions during the ozone season. Generally many parameters influence emissions as a function of time. Two of the most important variables are (1) source activity and (2) temperature.

6.6.1 SEASONAL CHANGES IN ACTIVITY LEVELS

Source activity for several important categories fluctuates significantly on a seasonal basis. Because VOC emissions are generally a direct function of source activity, seasonal changes in activity levels should be examined at the more important sources in the inventory. As an example, Vehicle Miles Traveled (VMT) may increase in the summer in certain locations due to increased vacation or other travel, possibly leading to somewhat higher VOC emissions from highway vehicles during the summer months. Because of the importance of highway vehicles in many areas, the agency should determine VMT during the ozone season and should use this seasonal rate, rather than an annual average, for estimating emissions in the inventory. Similarly, the agency should determine if the activity at other important sources changes significantly throughout the year. Other operations that might be more active in the warmer months or, in some cases, active only during the warmer months, include exterior surface coating, asphalt paving, gasoline handling and storage, power plants, open burning, and pesticide applications. On the other hand, some sources, due to summer vacation shutdowns or decreased demand for product, may be less active during the ozone season. Many sources, particularly industrial facilities, will show no strong seasonal change in activity. Little adjustment needs to be made in these cases to estimate the seasonal emissions component.

6.6.2 SEASONAL CHANGES IN TEMPERATURE

Another important variable is temperature, especially in that emissions from two of the most important VOC emission sources - highway vehicles and petroleum product handling and storage operations - are significantly influenced by temperature changes. As an example, breathing losses from fixed roof storage tanks increase at higher temperatures.

The following empirical formula from Section 4.3 in AP-42 shows the dependence of these losses on temperature.[1]

$$L_B = 2.21 \times 10^{-4} M \left[\frac{P}{14.7-P}\right]^{0.68} D^{1.73} H^{0.51} \Delta T^{0.50} F_p C K_c$$

Where: L_B = Fixed roof breathing loss (lb/day)

M = Molecular weight of vapor in storage tank (lb/lb mole)

P = True vapor pressure at bulk liquid conditions (psia)

D = Tank diameter (ft)

H = Average vapor space height, including roof volume correction (ft); See note (1) below

ΔT = Average ambient temperature change from day to night (°F)

F_P = Paint factor (dimensionless)

C = Adjustment factor for small diameter tanks (dimensionless)

K_c = Crude oil factor (dimensionless); See note (2) below

Note 1: The vapor space in a cone roof is equivalent in volume to a cyclinder which has the same base diameter as the cone and is one third the height of the cone.

Note 2: K_c = (0.65) for crude oil, K_c = (1.0) for gasoline and all other liquids.

Note in the above formula, that P, the true vapor pressure for a typical gasoline (RVP = 10), ranges from about 5.2 psia at a bulk liquid temperature of 60°F to 8.1 psia at 85°F. Hence, the term $[P/(14.7-P)]^{0.68}$ varies from about 0.66 to 1.15 over this range of bulk liquid temperatures. (Be aware that bulk liquid temperatures typically will exceed average ambient temperatures by several degrees, depending on tank color.[2]) This increase of about 70 percent demonstrates that evaporation potentially can be much more significant at higher summer temperatures. Thus, to adjust the inventory to estimate breathing loss emissions from fixed roof storage tanks during the ozone season, the agency should incorporate the appropriate temperature into the above formula to account for increased evaporation during warmer months. Temperature effects have to be accounted for in other petroleum product marketing and storage operations, as well. The effects of temperature on emissions from these other sources are also presented in Chapter 4 of AP-42. The reader should note that the empirical formulas for calculating storage tank losses are subject to change as a result of continuing testing programs. Hence, the most current AP-42 supplements should be consulted prior to making any storage tank calculations.

6.6.3 OTHER SEASONAL ADJUSTMENT CONSIDERATIONS

While source activity and temperature are two of the most important variables in determining seasonal fluctuations in the VOC emission inventory, other variables may be significant in certain instances. As an example, the use of air conditioning affects the magnitude of emissions from highway vehicles. As another example, emissions from floating roof tanks storing gasoline will depend on wind speed as well as on the Reid Vapor Pressure (RVP) of the gasoline. Typically, gasolines will have lower RVP in the summer, which tends to offset the increase in emissions expected if temperature were the only variable considered in the seasonal adjustment.[15]

For many sources, no major seasonal fluctuations in emissions are expected, due to changes in process variables or ambient conditions. For example, some industrial surface coating operations such as metal parts painting may use the same amount of solvent in their operations in each season of the year. For these sources, no seasonal adjustment is necessary and the annual emission rate may be assumed equal to the emission rate during the ozone season.

6.7 EMISSION PROJECTIONS

Projection inventories are needed by an agency to determine if a given area will achieve or exceed the ozone standard in future years. There are two basic types of projections, baseline and control strategy. Baseline projections are estimates of future year emissions that take into account both expected growth in an area and air pollution control regulations in effect at the time the projections are made. Included are regulations which have been adopted and will take effect at a future date. Control strategy projections, on the other hand, are estimates of future year emissions that also include the expected impact of changed or additional control regulations.

Baseline projection inventories of annual countywide emissions for the particular years of interest will probably not be available from past inventory efforts. Moreover, whatever projection inventories that do exist may not reflect all of the growth and control scenarios that the agency may wish to evaluate. Hence, the agency will have to devote resources to the development of projection year inventories. Specific recommendations for making projections are discussed in the following sections. These general considerations should be kept in mind from the outset of inventory planning:

1. To a large extent, projection inventories will be based on forecasts of industrial growth, population, land use, and transportation. The air pollution agency should not attempt to make these forecasts but, rather, should rely on the local Metropolitan Planning Organization (MPO), Regional Planning Commission (RPC), or other planning agencies to supply them. This course has several advantages. First, it would be extremely costly for the air pollution agency to duplicate the forecasts made by other planning agencies. Second, the air pollution agency needs to base its emission projections on the same forecasts as to other governmental planning agencies. This consistency is necessary to foster the credibility of any proposed control programs based on emission projections.

2. Anticipated control strategies being considered in the modeling area should be known in order to design projection inventories to reflect these strategies. This consideration may influence the type of data collected as well as the structure of the inventory itself. As an example, if the agency wants to test the effect of applying Stage I controls on tank trucks unloading only to service stations above a particular size, it may be desirable to treat these particular stations as point sources rather than lumping them in a general service station area source category.

3. It is important that all emissions projected for future years be based on the same methodologies and computation principles as the base year emissions. For example, if a traffic model is used for estimating travel demand for the base year, the same traffic model should be applied to estimate travel demand for projection years. Use of the same methodology assures consistency between base year and projection year emission estimates and prevents possibly spurious inventory differences from changes in methodology.

4. Projection inventories will always be open to attack because of their somewhat speculative nature. The technical credibility of emissions projections will be a function of their reasonableness, of the amount of research and documentation of assumptions, and of the procedures or methodologies used to make the projections. Some degree of uncertainty will always accompany emission projections. This fact should be acknowledged openly. The art of projecting emission inventories is not in eliminating uncertainty, but in learning how to minimize it. Internal and external review of emission inventory projections will improve their technical quality and enhance their credibility.

6.7.1 MAJOR POINT SOURCE PROJECTIONS

The best approach for projecting emissions from major point sources is to obtain information on each facility. This type of projections information would ideally be determined by contacting plant management, but it could be solicited on questionnaires. Generally, questionnaires would not be sent out solely to obtain projection information, but this additional information may be elicited on questionnaires used in periodic updates of the baseline inventory. Permit applications submitted to various Federal, state, and local agencies should also be screened to get information on expected expansion or new construction. In addition, the local metropolitan planning organization and other planning bodies should be contacted for any information they may have on projected industrial expansion and for comment on the reasonableness of any plans submitted by plant personnel.

Once this type of projected plant growth information is obtained, the agency needs to determine what regulations will apply in order to estimate controlled emissions. In the baseline projection, existing applicable regulations would be assumed and evaluated. For instance, a fossil fuel power plant now under construction and expected to start operation in two years would be subject to Federal New Source Performance Standards (NSPS) for particulate, SO_2 and NO_x. Hence, unless plant personnel indicated that more stringent controls will be applied, the resulting emissions could reasonably be assumed to be equal to the standard. Similarly, the effects of any alternate standards would have to be evaluated. Since emission standards are commonly expressed in terms of emission factors, mass loading rates, or concentrations, the procedures outlined earlier in this chapter can be followed to estimate controlled emissions.

When obtaining projection information from plant management, the agency should inquire if the indicated increase in activity will occur at the existing facility, at another existing plant, or at a new plant. If growth will occur at an existing facility, the agency also needs to determine if it will be expansion to existing capacity or will require plant modifications to increase capacity. These considerations are especially important for major sources, since in certain areas new emissions may be limited by growth allocations. They will also help the agency to determine what additional control measures are likely to be required. The completion dates of any expansion or new construction are also needed in order to determine if a given source will impact on the projection inventory.

As an example of making point source projections for specific sources, consider a facility employing a large open top vapor degreasing operation that emitted 100 tons of solvent per year in 1977, based on an annual production of 10,000 units of a particular metal part. Assume that no control measures are being taken to reduce solvent losses from the process. Suppose a plant contact is made, and it is learned that 5 percent more metal parts will be produced per year until 1982 using the existing operation, and that, in 1986, a replacement facility will be brought on line at another location to produce 20,000 parts per year. Moreover, suppose that the source is located in an ozone attainment area where RACT is not required on VOC sources. To estimate VOC emissions from this source for a 1982 projection inventory, one could assume that, since no additional controls are expected, the current emission level can be multiplied by the cumulative growth rate in metal parts production (i.e., 5 years at 5 percent/year = $[1.05]^5$ = 1.28, or 128 percent) to estimate 1982 VOC emissions. In this manner, emissions for 1982 can be estimated at 128 percent of 100, or 128 tons per year, and the point source record for this projection year should be adjusted take this growth into account.

Continuing this example, suppose a control strategy projection is desired for 1987 to evaluate the effect of RACT as an alternate control strategy. In this case, both growth and controls must be considered. As a first approximation, if a similar open top vapor degreasing operation is used in the new facility, one can assume that, since 1987 production is twice 1977 production, uncontrolled emissions from the replacement plant will be twice those of 1977, or 200 tons per year. Since the new plant will be subject to RACT in this control scenario, VOC emissions will be reduced 45 to 60 percent from the uncontrolled case.[10] Hence, projected emissions in 1978 would be only 80 to 110 tons per year, depending on which RACT measures were instituted. Note that, since the replacement facility is to be built between 1977 and 1987, a new point source should be included in the 1987 projection inventory, and the old source deleted or assigned zero emissions in the projected year.

As is obvious from this example, even when projection information is available for specific facilities, certain assumptions will have to be made to project emission levels for some future year. For instance, in the 1982 baseline projection, it was assumed that emissions would increase proportionately with production. Depending on the nature of the operation, this may not be entirely accurate. This same assumption, along with an assumed emission reduction due to RACT, was also used in making the 1987 control strategy projection. This underscores the point made previously that projections are somewhat speculative in nature.

6.7.2 AGGREGATE POINT SOURCE PROJECTIONS

In many instances, projection information will not be available on every facility in an area of interest. Some plant managements will not be willing or able to provide forecasts of their corporate plans, especially for distant years. In addition, many plants in certain source categories, such as small industrial boilers, will be too small and too numerous to warrant the individual solicitation of projection information. In these situations, other procedures need to be employed to project future emissions. Two possible approaches are discussed below.

In the case of large point sources, projection information may be available on many sources within a given category, but for various reasons, may not be obtainable for one facility or several. For example, 10 paint manufacturing plants may operate in the area of interest, but successful contacts may have been made to only eight of these. In this situation, a reasonable approach to projecting growth and emissions at the remaining two plants would be to evaluate the growth trends in the plants for which projections are known and to apply them to the plants for which no information is available. In the example of the paint manufacturing plants, if production were expected to expand by 6 percent per year, on average, for the eight plants, then this rate could be applied to the two plants to estimate expected growth. Then, knowing the increase in production, the appropriate control measures would be considered in making a baseline projection. Good engineering judgement is needed in this practice to screen out any unreasonable projections that may occur.

For smaller points sources, obtaining projection information from each plant may not be feasible. In these cases, the rate of activity growth may be assumed equivalent to that of some surrogate indicator for which projections have been made by local MPOs or by OBERS.[16] For example, one might assume that cold cleaning operations would grow at the same rate as industrial manufacturing, which can, in turn, be estimated from projections of employment in industrial manufacturing categories.

Regardless of what surrogate indicators are used for making projections, the basic calculations are the same. The ratio of the value of the surrogate indicator in the projection year to its value in the base year is multiplied by the aggregate base year activity level for the point source category in the base year. Because the projection years of interest to the air pollution control agency will not often be the years for which growth projections have been made, interpolation of projection year data may be required. Local planning agency input should be sought regarding whether straight line or other interpolation methods should be employed.

6.7.3 AREA SOURCE PROJECTION PROCEDURES

Two approaches can be used for making growth projections of area source emissions. The more accurate approach involves projecting the activity levels themselves. The more common approach, however, involves the use of surrogate growth indicators to approximate the increase or decrease of each activity level.

The first of these approaches is generally employed when a local survey has been made or when other local estimates projecting growth in specific areas are available. For example, if a survey of dry cleaners has been performed, and the average growth in the modeling area is projected to be 5 percent per year, then in 5 years, dry cleaning activity would increase by 28 percent.* As another example, a local asphalt trade association may be may be able to project area cutback asphalt use in a future year. When considering such estimates, the inventorying agency must recognize the possibility of deliberate or inadvertent biases, through wishful thinking or self serving motives, and it should strive to obtain opinions which are as objective as possible. Moreover, the agency should be careful to determine whether or not such estimates of future activity levels anticipate the effect of control measures. This is important, as some estimates may be used more appropriately in control strategy projections than in the baseline inventory. Any such projections should be consistent with projections made by other planning agencies.

A common alternative to projecting activity levels directly is to use indicators of growth. In the context of projections, a surrogate growth indicator is one whose future activity is fairly certain and is assumed to behave similarly to the specific activity levels of interest. The most commonly used surrogate growth indicators are those parameters typically projected by a local MPO such as population, housing, land use and employment. As one example, the quantity of consumer/commercial solvent use in a projection year might be assumed to grow proportionaly with population. Hence, if population in an area increased by 10 percent from the base year through the projection year, consumer/commercial solvent use could be assumed to increase by 10 percent, as well. Regardless of what variables are used as growth surrogates, the basic calculation is the same: the ratio of the value of the growth indicator in the projection year to its value in the base year is multiplied by the area source activity level in the base year to yield the projection year activity level.

In making area source emission projections, control measures will have to be considered for certain source categories. The effects of controls on area sources can generally be simulated by changes in either (1) emission factors or (2) activity levels, depending on the source and the nature of the control measure(s) being considered. As an example of the first of these approaches, RACT for gasoline service stations could be accounted for by using an emission factor lower than the uncontrolled factor given in AP-42.[17] As an example of the second approach, RACT for cutback asphalt paving could be evaluated by simply reducing the activity level in proportion to the fraction of cutback asphalt that would be replaced with emulsified asphalt.[18]

Projection information on several area source categories is summarized in Table 6.7-1.

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*$(1.05)^5$ 1.28, or a 28 percent increase

TABLE 6.7-1. Growth Indicators for Projecting Emission Totals for Area Source Categories[19]

Source Category	Growth Indicators	Information Sources
Gasoline handling	Gasoline demand, vehicle use (VMT), or population	U.S. Department of Transportation, State Transportation Agency, State Tax Agency, Local MPO or Reference 20
Drycleaning	Population, retail service employment	Solvent supplier, trade association
Degreasing	Industrial employment	Trade association
Non-industrial surface coating	Population or residential dwelling units	Local MPO
Cutback asphalt	Consult industry and local road departments	Consult industry and local road departments
Pesticide applications	Agricultural operations	State department of agriculture, local MPO
Miscellaneous solvent use	Population	Local MPO
Aircraft, commercial, and general	Projections should be done case by case - Projected land use maps may be useful	Local airport authority, MPO, state aviation system plan
Aircraft, Military	Estimate on individual	Local airport authorities and appropriate military agencies
Agricultural equipment	Agricultural land use, agricultural employment	Local MPO
Construction equipment	Heavy construction employment (SIC code 16)	Local MPO
Industrial equipment	Industrial employment (SIC codes 10-14, 20-39, and 50-51) or industrial landuse area	Local MPO

TABLE 6.7-1. (cont.). Growth Indicators for Projecting Emission Totals for Area Source Categories

Source Category	Growth Indicators	Information Sources
Lawn and garden equipment	Single-unit housing or population	Local MPO
Off highway motorcycles snowmobiles, and small pleasure crafts	Population	Local MPO
Railroads	Revenue ton-miles	References 21, 22
Ocean-going and river cargo vessels	Cargo tonnage	Local port authorities, U.S. Maritime Administration, or U.S. Army Corps of Engineers
Residential fuel combustion	Residential housing units or population	Local MPO and Reference 23
Commercial/industrial fuel combustion	Commercial/institutional employment, population, or land use area	Local MPO, land use projections
Industrial fuel combustion	Industrial employment (SIC codes 10-14, 20-39, and 50-51) or industrial land use	Local MPO, land use projections
Solid waste disposal, on site incineration, open burning	Based on information gathered from local regulatory agencies	
Fires: Managed burning agricultural field burning, frost control (orchard heaters)	Based on anticipated local regulations as indicated by information sources	
Fires: forest wildfires, structual fires	Difficult to project - see Chapter 4	

6.7.4 PROJECTION REVIEW AND DOCUMENTATION

Because the projection inventories are so important in control strategy development, they should be reviewed in draft form by the air pollution control agency and as many other involved groups as possible. The projection inventories will survive this careful scrutiny if all assumptions, procedures and data sources are carefully documented. This review and documentation process will help assure that the projections are (1) consistent with any other projections being made in the area, (2) objective and not biased toward any particular policy, etc., (3) open, with all assumptions, and estimates clearly stated for public review, and (4) defensible because of all of the above.

The key aspects of projections that will invite criticism are: (1) which indicators are used for projecting activity level growth, (2) when and where this growth will occur, and concomitantly, whether it will be by expansion of existing facilities or by new construction, and (3) what emissions will be associated with this growth, either in the baseline case or as a result of various candidate control strategies. When planning, compiling and reviewing the point source projection inventory, the agency should focus particular attention on these issues.

It is especially important that consistent methodologies be used for the base year and the projection years to estimate emissions for each source. For example, if emissions from gasoline evaporation at service stations in a base year are estimated as a result of a special study, such as questionnaires to individual service stations, it would be inconsistent to estimate such emissions for a future year based on projected VMT. Such inconsistencies likely will lead to changes in emissions estimates that are due not to growth or control measures but, rather, to changes in the inventory procedures themselves.

A test to determine if the various base year and projection year methodologies are mutually consistent is to judge whether each projection year methodology, if applied to the base year data, would result in a replication of the base year emission totals. If significant discrepancies are found, then one methodology should be chosen to apply to both years. Generally, in this regard, any methodology which applies growth factors to the base year total to estimate projection year emissions or activity levels will meet this consistency criterion.

References for Chapter 6.0

1. Compilation of Air Pollution Emission Factors, Third Edition and Subsequent Supplements, AP-42, Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 1977.

2. Evaporation Loss from External Floating-Roof Tanks, Second Edition, API Publication 2517, American Petroleum Institute, Washington, DC, February 1980.

3. Standard Industrial Classification Manual, Executive Office or the President, Office of Management and Budget, Washington, DC, 1972.

4. Lew Heckman, "Organic Emission Inventory Methodology for New York and New Jersey," presented at the Emission Inventory/Factor Workshop, Raleigh, NC, September 13-15, 1977.

5. Malesh C. Shah and Frank C. Sherman," A Methodology for Estimating VOC Emissions From Industrial Sources," paper presented at the 71st Annual Meeting, American Institute of Chemical Engineers, November 1978.

6. Methodology for Inventoring Hydrocarbons, EPA-600/4-76-013, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 1976.

7. County Business Patterns, Bureau of the Census, U.S. Department of Commerce, Washington, DC, Annual.

8. Recommended Policy on the Control of Volatile Organic Compounds, 42 FR 35314, July 8, 1977.

9. Clarification of Agency Policy Concerning Ozone SIP Revisions and Solvent Reactivities, 44 FR 32042, June 4, 1979, 45 FR 32424, May 16, 1980, and 45 FR 48941, July 22, 1980.

10. Control of Volatile Organic Emissions from Solvent Metal Cleaning, EPA-450/2-77-022, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1977.

11. Control Techniques for Volatile Organic Emissions From Stationary Sources, EPA-450/2-78-022, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1978.

12. David M. Pitts, Emissions Control Options for the Synthetic Organic Chemicals Manufacturing Industry, Knoxville, TN, EPA Contract Number 68-02-2577, Hydroscience, Inc., June 1979.

13. End Use of Solvents Containing Volatile Organic Compounds, EPA-450/3-79-032, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1979.

14. Volatile Organic Compounds Species Data Manual, EPA-450/3-78-119, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1978.

15. E. M. Shelton, Motor Gasolines, Winter 1978-79, BETC/PPS-79/3, U.S. Department of Energy, Bartlesville, OK, July 1979.

16. "Regional Economic Activity in the U.S.", 1972 OBERS Projections, Bureau of Economic Affairs, U.S. Department of Commerce, and Economic Research Services, U.S. Department of Agriculture, 1974.

17. Hydrocarbon Control Strategies for Gasoline Marketing Operations, EPA-450/3-78-017, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1977.

18. Control of Volatile Organic Compounds from Use of Cutback Asphalt, EPA-450/2-77-037, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1977.

19. Procedures for the Preparation of Emission Inventories for Volatile Organic Compounds, Volume II, EPA-450/4-79-018, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

20. Energy Outlook 1978-1990, Exxon Company, Houston, TX, May 1972.

21. Annual Railroad Reports prepared for the U.S. Interstate Commerce Commission.

22. Yearbook of Railroad Facts, Association of American Railroads, Washington, DC. Annual publication.

23. U.S. and World Energy Outlook Though 1990, Projection Interdependence, U.S. Congressional Research Service, Washington, DC, November 1977.

7.0 SUPPORTING DOCUMENTATION AND REPORTING

The final phase in the development of an emission inventory is to present the data which has been collected, compiled and analyzed. The data can be presented in a variety of forms, from unorganized raw data listings to aggregated summary reports. Generally, the form in which the data will be presented is determined by (1) how the data can be most efficiently summarized, and, more importantly, (2) why the inventory was conducted.

Documentation supporting the VOC inventory is a necessary part of all summary reports. However, the degree of documentation, like the reporting format, will also depend on the end use of the inventory data. In this chapter, some examples of both inventory data presentation and documentation will be discussed, as well as how inventory end uses can determine both the presentation and the documentation.

7.1 REPORTING FORMS

The purpose of the emission inventory is the primary consideration when deciding on a reporting format. An inventory developed only for research purposes can be presented in many forms. For example, a raw data listing, which basically presents the data compiled in the inventory, could consist simply of computer printouts of sources and emissions. The printouts would require no additional preparations for agency internal use.

On the other hand, reports which are for use outside an agency will usually be more formal than reports for internal use. External use reports, such as public information pamphlets and emissions control program documents, require formating which clearly presents summarized inventory data. Since these reports summarize the inventory data, they are referred to as summary reports.

A summary report includes information that has been aggregated and organized in some manner during the reporting process. For instance, a summary report of total VOC emissions from all dry cleaners in an area would of necessity involve a totaling of emission estimates stored in certain file records. In many instances, some analysis of the data might also be performed in the process of preparing a summary report. A more formal summary report will convey the inventory information to the document reader clearly and concisely.

An example of formal inventory reports are State Implementation Plan (SIP) submissions or other control strategy inventory reports. These reports must meet formating requirements set fourth in local, state and EPA regulations. Because requirements may differ for each agency as well as for different years, the most recent Federal Register or local administrative code should be consulted when reporting control program inventories. As a guide, the reporting format required in the 1982 State Implementation Plan submittals for VOCs is shown in Table 7.1-1.

	Base Year		Projection Year	
	Point	Area	Point	Area
STORAGE, TRANSPORTATION AND MARKETING OF VOC				
Oil and Gas Production & Processing				
Gasoline and Crude Oil Storage[1]				
Synthetic Organic Chemical Storage & Transfer				
Ship and Barge Transfer of VOC				
Barge and Tanker Cleaning				
Bulk Gasoline Terminals[2]				
Gasoline Bulk Plants[3]				
Service Station Loading (Stage I)				
Service Station Unloading (Stage II)				
Others				
INDUSTRIAL PROCESSES				
Petroleum Refineries				
Lube Oil Manufacture				
Organic chemical Manufacture				
Inorganic Chemical Manufacture				
Fermentation Processes				
Vegetable Oil Processing				
Pharmaceutical Manufacture				
Plastic Products Manufacture				
Rubber Tire Manufacture				
SBR Rubber Manufacture				
Textile Polymers & Resin Manufacture				
Synthetic Fiber Manufacture				
Iron and Steel manufacture				
Others				
INDUSTRIAL SURFACE COATING				
Large Appliances				
Magnet Wire				
Automobile				
Cans				
Metal Coils				
Paper				
Fabric				
Metal Wood Products				
Miscellaneous Metal Products				
Plastic Parts Painting				
Large Ships				
Large Aircraft				
Others				
NON-INDUSTRIAL SURFACE COATING				
Architectural Coatings				
Auto Refinishing				
Others				
OTHER SOLVENT USE				
Degreasing				
Dry Cleaning				
Graphic Arts				
Adhesives				
Cutback Asphalt				
Solvent Extraction Processes				
Consumer/Commercial Solvent Use				
Other				
OTHER MISCELLANEOUS SOURCES				
Fuel Combustion				
Solid Waste Disposal				
Forest, Agricultural, and Other Open Burning				
Pesticide Application				
Waste Solvent Recovery Processes				
Stationary Internal Combustion Engines				
MOBILE SOURCES				
Highway Vehicles				
a. Light Duty Automobile				
b. Light Duty Trucks				
c. Heavy Duty Gasoline Trucks				
d. Heavy Duty Diesel Trucks				
e. Motorcycles				
Off Highway Vehicles				
Rail				
Vessels				

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[1] Includes all storage facilities except those at service stations and bulk plants.
[2] Loading tank trucks and rail cars.
[3] Storage and transfer operations.

Table 7.1-1. Tabular Reporting Format.

To compile and report detailed point source data, the example in Figure 7.1-1 can be followed. This format is designed to report emissions from specific processes for each facility inventoried as a point source. Process emission points which can be used in completing Figure 7.1-1 are listed in Appendix B. Use of this table will provide the reader with an accounting of point source emissions which appear in Table 7.1-1.

In addition to required reporting formats, a wide variety of tables and graphic displays can be employed to present inventory data. Charts, tables and graphs can quickly convey to the reader emissions breakdowns by industries, geographical areas, or source size. Emission trends and the effects of control programs can also be tabulated or graphed. Several examples of tables and graphs are included here to provide some ideas on how data can be presented.

Figure 7.1-2 is an example of a pie chart to illustrate the relative importance of VOC emission sources. Figure 7.1-3 is an example of how to show the relative importance of sources by bar graphs. Note that projection year emissions can be compared with base year emissions. Figure 7.1-4, an expansion of a sub part of Figure 7.1-3, provides the reader with a detailed breakdown of organic solvent emissions by source type. Other figures and tables may be used if they illustrate the particular characteristics of an emission inventory.

How the inventory data can most efficiently be summarized will depend on time and manpower available to assemble a report. Tabular reports are the most common kind of report, as they can be readily generated from computerized inventory systems. Certain types of graphic displays, on the other hand, are difficult to produce using a computer and require time and manpower to develop by hand. Most of the NEDS raw data and summary reports available to the public are of the tabular variety. The various NEDS reporting programs are described in limited detail in Appendix F, and in greater detail in Reference 1.

Summary inventory data tables, together with raw data listings of equipment, activity levels, and emissions from individual sources, constitute the most frequently used reports in the development and implementation of an ozone control program. Because there exists a need at certain levels to be able to compare baseline inventories from one area to another, as well as to determine the impact of employing various control strategies, such as RACT, a common format is considered desirable to promote reporting consistency. The format presented in Table 7.1-1 is required when reporting VOC emissions in 1982 SIPs.[2] This format allows the agency to identify all major source categories of volatile organic compound emissions and to determine the reductions that may occur in an area if various control strategies are employed.

7.2 SUPPORTING DOCUMENTATION

Documentation of the emission inventory is highly useful for all VOC inventory uses. While inventories developed for inhouse use may not require the same degree of documentation as inventories used in State Implementation

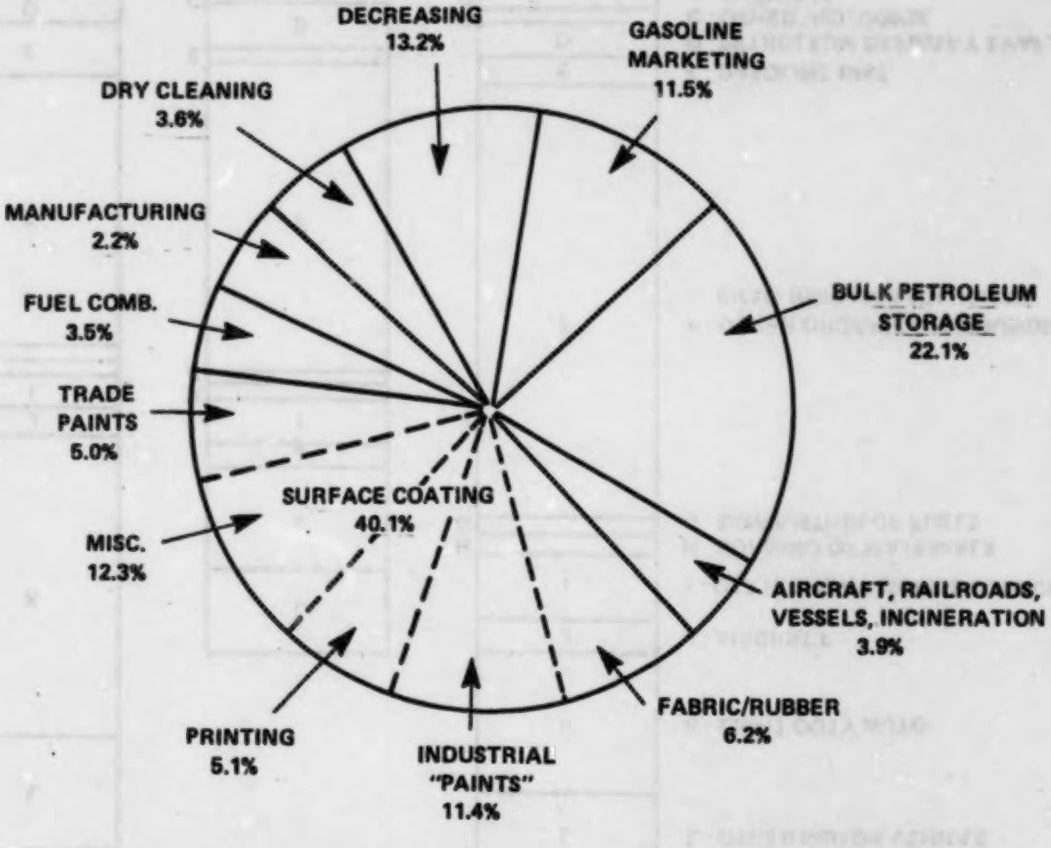
Principal Emitting Operations at Major VOC Source Categories

Name and Location Flat Tire, Inc.
100 Bias Beltway, Whitewall, WI

Major VOC Source Category Rubber Tire Manufacturing

Principal Operations	Emissions (tons/year)
Undertread and Sidewall Cementing	610
Bead Dipping	52
Tire Building	200
Tread End Cementing	96
Green Tire Spraying	643
Tire Curing	13
Solvent Mixing	10
Solvent Storage	10
Other (milling)	6
Other Tread and Sidewall Preparation	6
TOTAL	1646

Figure 7.1-1. Example Use of Point Source Process Emissions Reporting Table



(NOTE: HIGHWAY VEHICLES ARE EXCLUDED)

Figure 7.1-2. Example "pie" chart to illustrate source category contributions to total emissions.

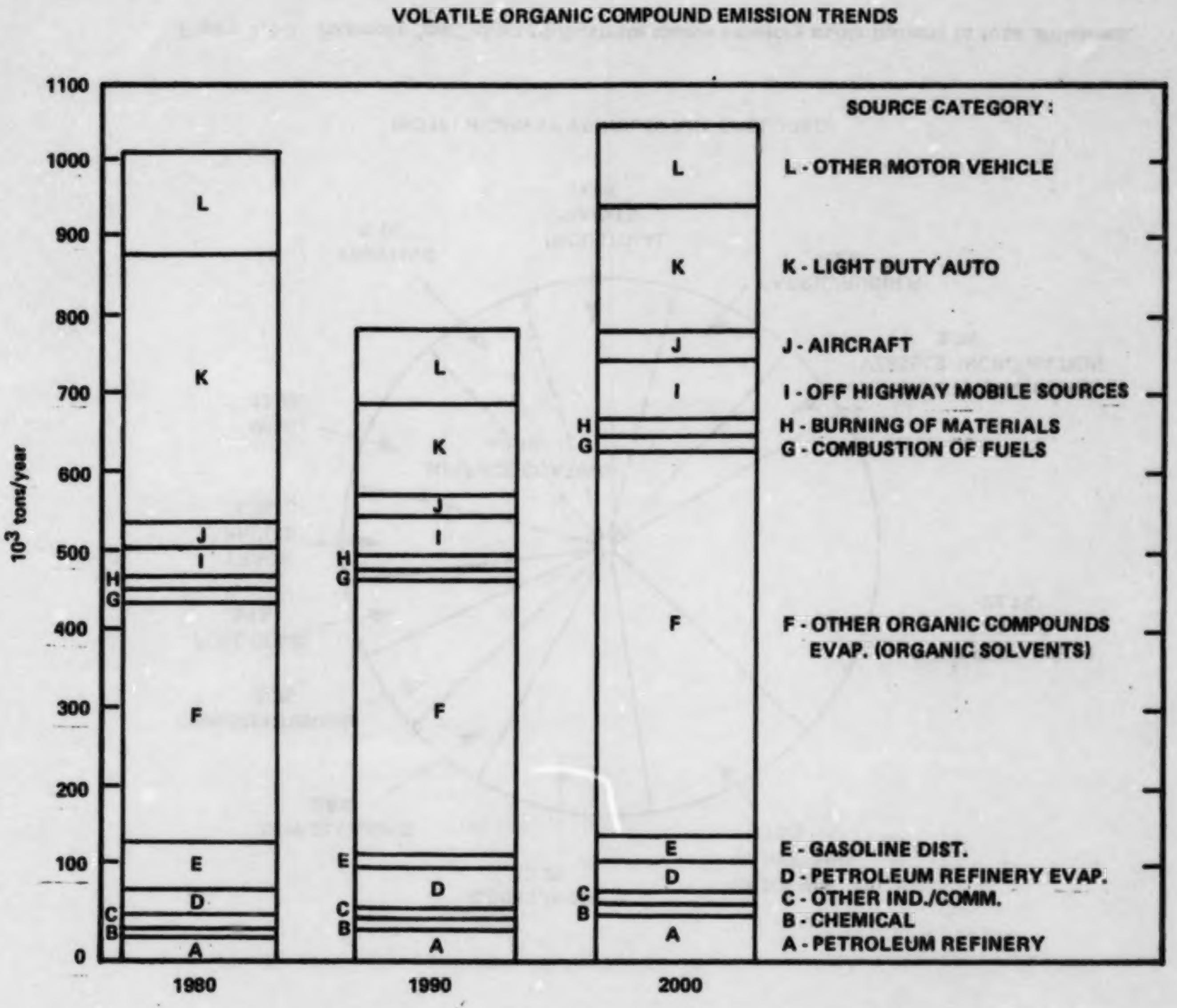
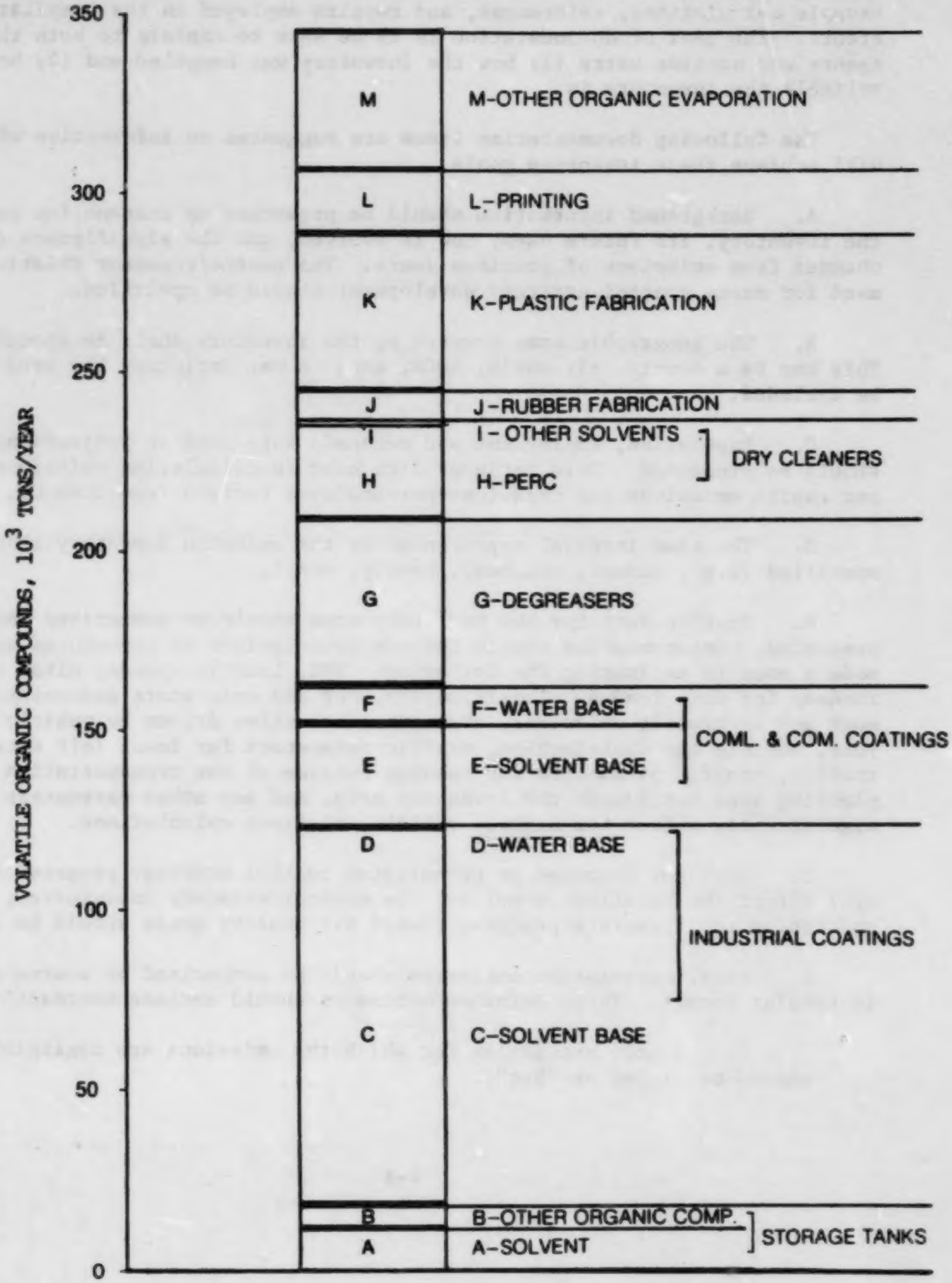


Figure 7.1-3. Example bar chart to illustrate source category contributions to total emissions and projected emission trends.

Figure 7.1-4

BREAKDOWN OF ORGANIC SOLVENT EMISSIONS BY SOURCE TYPE



Plans, good documentation of all inventories will help an agency when more formal inventories must be developed. Therefore, compiling and maintaining documentation in support of data are recommended in all emission inventories.

Documentation entails keeping a record of all methods, assumptions, example calculations, references, and results employed in the compilation effort. The goal of documentation is to be able to explain to both the agency and outside users (1) how the inventory was compiled and (2) how reliable the inventory is.

The following documentation items are suggested as information which will achieve these inventory goals.

A. Background information should be presented on reasons for compiling the inventory, its future uses, how it evolved, and the significance of changes from emissions of previous years. The source/receptor relationship used for ozone control strategy development should be specified.

B. The geographic area covered by the inventory shall be specified. This may be a county, air basin, AQCR, etc. A map depicting the area should be included.

C. Population, employment and economic data used in projections should be presented. This includes data used in calculating emissions with per capita emissions and emissions-per-employee factors (see Item H).

D. The time interval represented by the emission inventory should be specified (e.g., annual, seasonal, hourly, etc.).

E. Traffic data for the inventory area should be summarized and presented. Documentation should include descriptions of procedures and models used in estimating the following: VMT, traffic speeds, miles of roadway for each roadway classification, hot and cold start percentages, hot soak and in transit emissions, average annual miles driven by vehicle model year, vehicle age distribution, traffic parameters for local (off network) traffic, traffic parameters for roadway outside of the transportation planning area but inside the inventory area, and any other parameters which significantly affect the highway vehicle emissions calculations.

F. Note any proposed or promulgated control strategy programs that will affect the baseline inventory. In control strategy inventories, graphs and tables to illustrate progress toward air quality goals should be included.

G. Baseline emission estimates should be summarized by source category in tabular format. These emission estimates should exclude nonreactive VOC.

1. Source categories for which the emissions are negligible should be listed as "Neg".

2. Source categories for which there are no emissions in the study area should be listed as "0".

H. A narrative should also be presented for each category of the inventory. The narrative should contain at least the following:

1. Procedures used to collect the data - Procedures should be presented which describe completely how the data were collected and analyzed. A concise point source/area source definition should also be included.

2. Sources of the data - A complete description of the types of sources accessed in the course of compiling the inventory should be presented. These sources would include, for example, permit files, inspection reports, source test data, actual company inquiries, other agencies, etc. A statement should be included assessing the completeness of the data collected.

3. Copies of questionnaires - Samples of questionnaires mailed to various source categories for the collection of data should be included as part of the inventory documentation.

4. Questionnaire statistics - Statistics regarding the questionnaires should be presented. This information may include:

a. The number of questionnaires sent

b. The number for which response was received

c. The method of extrapolating available information for nonrespondents

d. Any assumptions made regarding the data received or not received.

5. Emission factor citation - Emission factors used for the calculation of emissions should be clearly stated. Factors from sources other than AP-42 may be used but a rationale for the use of these other factors should be provided. Source test data are preferred over emission factors.

6. Method of calculation - Sample calculations for each type of computation should be presented, to allow for an independent verification of the computations. (Some emission factors are frequently misused.) Techniques for excluding nonreactive VOC from the inventory should be described

7. Assumptions - Any assumptions made in any part of the procedures should be clearly stated.

8. Items not included - Any sources of emissions which are not included in the inventory should be itemized in the narrative. A statement as to why these sources were excluded should be presented. Possible reasons for exclusion could be:

a. The emissions from these sources are known to be negligible

b. No emission factors exist, and no source test data are available to allow computation of these emissions

c. Emissions from these sources have been taken into account by considering a background ozone concentration

9. A list of references should be included as a final section of the narrative.

Some examples of the above documentation items are included in Appendix E. Additional items should be included in the inventory documentation, if they will further clarify and support the inventory.

Once an inventory is well documented and is technically sound, it can be useful for several years with only annual updating. In certain cases, adequate documentation may allow the agency to forego an update of certain portions of the inventory, so that more resources can be devoted to higher priority items in an ozone control program.

Technically correct and documented inventories are always in the best interest of all air pollution management agencies.

References for Chapter 7.0

1. AEROS Manual Series, Volume III: Summary and Retrieval, Second Edition, EPA-450/2-76-009a, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1977.

2. Emission Inventory Requirements for 1982 Ozone State Implementation Plans, Draft, EPA-450/4-80-016, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1980.

APPENDIX A - GLOSSARY OF IMPORTANT TERMS

Activity level: Any variable parameter associated with the operation of a source (e.g., production rate, fuel consumption, etc.) that may be correlated with the air pollutant emissions from that source.

AP-42: EPA Document Number AP-42, Compilation of Air Pollutant Emission Factors, Environmental Protection Agency, Research Triangle Park, North Carolina. Supplements are published regularly. This document includes process descriptions and emission factors for a broad range of criteria pollutant emission sources.

Area source: Normally, an aggregation of all sources not defined as point sources in a specific geographic area. Area sources ususally include all mobile sources and any stationary sources too small, difficult, or numerous to classify as point sources. The area source emissions are assumed to be spread over a broad area.

Baseline projection: Estimate of emissions expected in future years, based on a growth and emission control scenario. Baseline emission controls for a given projection year include only those controls that have been legally mandated at the time of preparing the projection.

Breathing loss: Loss of vapors from storage tanks due to diurnal warming and cooling.

Control strategy projection inventory: An inventory of emissions, for a future year, which differs from the baseline inventory in that it takes into account the expected impact of a proposed control strategy.

Correction factors: Special multipliers employed in emission calculations to more accurately adjust the resulting emission estimates to take into account special parameters such as temperature, pressure, operating load, etc. Appropriate correction factors are particularly important in accurately calculating organic emissions from mobile sources and petroleum product storage and handling operations.

Degreasing: Any operation in which impurities such as greases and oils are removed from a surface using an organic solvent.

Diffusion modeling: A mathematical technique for calculating the atmospheric distribution of air pollutants based on emissions data and meteorological data for an area. Also referred to as dispersion modeling.

Documentation (inventory): Refers to a compilation of the methods, assumptions, calculations, references, etc., that are employed in the development of an inventory.

Dry cleaning: The practice of cleaning textile materials by treatment with organic solvents. The most common dry cleaning solvents are perchloroethylene and Stoddard.

Emission factor: An estimate of the rate at which a pollutant is released to the atmosphere as the result of some activity, divided by the rate of that activity (e.g., production rate).

Emission inventory: A compilation of information relating to sources of pollutant emissions, including location, quantity of emissions number and type of control devices, stack dimensions and gas flow rates, and additional pertinent details.

Empirical Kinetic Modeling Approach (EKMA): A source/receptor relationship developed by EPA for estimating the overall reduction of volatile organic compound levels needed in an urban area based on existing oxidant levels and VOC/NO_x ratios.

Evaporative losses: Emissions caused by the vaporization of materials (generally solvents) at normal atmospheric temperatures and pressure conditions.

Exhaust gas: Any gas, along with any particulate matter and uncombined water contained therein, emitted from a source to the atmosphere.

Fugitive organics: Organic compounds from a source that are not emitted through stacks, vents, or other confined air streams.

Gasoline marketing operations: The operations and systems associated with the transportation of gasoline from refineries to bulk terminals, to bulk storage, to dispensing outlets, and to vehicle gas tanks.

Gridding and subcounty allocation: The practice of distributing emissions or any other parameter from a larger geographical area (usually a county) to a smaller geographic area (i.e., a grid) using data presumed to be proportional to the parameter being distributed.

Hydrocarbons: Any compounds containing only carbon and hydrogen. The term "hydrocarbon" is often used synonymously with "volatile organic compounds", although the latter also includes hydrocarbon derivatives, as well.

Imprecision, emission inventory: That error in an emission inventory due to the variability (or random error) in the data used in determining the inventory.

Inaccuracy, emission inventory: That error in an emission inventory due to omissions, errors, and biases in the data used in determining the inventory.

Inventory: A compilation of source, control device, emissions, and other information relating to sources of a pollutant or group of pollutants.

Land use projection: Estimate of land use in a future year (often given in terms of land use maps representing the projected conditions).

Material balance: Technique used to estimate emissions from a source by accounting for the weights of one or more substances in all incoming and outgoing process streams.

Methane: The simplest hydrocarbon species; often excluded from VOC measurements or inventories because it is essentially unreactive in atmospheric photochemical reactions.

Mobile source: Any moving source of air pollutants, such as automobiles, vessels, locomotives, aircraft, etc.

Motor vehicles: Motor powered vehicles such as automobiles, trucks, motorcycles and buses, operated primarily on streets and highways.

National Emission Data System: An automatic data processing system developed by EPA for storage and retrieval of source and emission data.

Nitric oxide (or nitrogen oxide): One of the two oxides of nitrogen which are collectively referred to as NO_x (q.v.). The amount of nitric oxide (NO) in NO_x is often reported in terms of the quivalent weight of nitrogen dioxide (NO_2), in which case its true weight is only 30/46 of the reported weight.

Nitrogen dioxide: One of the two oxides of nitrogen which are collectively referred to as NO_x (q.v). The total weight of NO_x is often reported "as Nitrogen dioxide (NO_2)", which is not the true weight of the mixture but the weight which would be attained if all the nitric oxide (NO) were converted to NO_2.

Nonmethane: Excluding methane (CH_4).

Nonmethane hydrocarbon: All hydrocarbons, or all VOC, except methane.

Office of Business Economics, Research Service (OBERS): Acronym used in reference to projections prepared jointly by the U.S. Department of Commerce, Bureau of Economic Affairs, Office of Business Economics and the U.S. Department of Agriculture, Economic Research Service, for the U.S. Water Resources Council, April 1974.

Oxides of nitrogen: In air pollution usage, this comprises nitric oxide (NO) and nitrogen dioxide (NO_2); usually expressed in terms of the equivalent amount of NO_2.

Ozone: Three atoms of oxygen (O_3) combined through complex photochemical reactions involving volatile organic compounds and oxides of nitrogen; the principal chemical component of the photochemical oxidant formed in photochemical air pollution.

Ozone control strategy: A plan developed by an agency to control ambient ozone levels within its jurisdiction.

Ozone precursors: Volatile organic compounds and oxides of nitrogen, as air pollutant emissions and as air contaminants, undergo a series of reactions under the influence of ultraviolet light from the sun, to form photochemical oxidants, including ozone.

Ozone season: That period of the year during which conditions for photochemical ozone formation are most favorable. Generally, sustained periods of direct sunlight (i.e., long days, small cloud cover) and warm temperatures.

Paraffins: Saturated, nonaromatic hydrocarbon compounds, also known as long-chain alkanes.

Photochemistry: The chemistry of reactions which involve light as the source of activation energy.

Photochemical model (air quality): A detailed computer model that estimates ozone concentrations both as a function of space and time by directly simulating all of the physical and chemical processes that occur during the photochemical process.

Point source: Generally any stationary sources for which individual records are collected and maintained. Point sources are usually defined as any facility which releases more than a specified amount of a pollutant.

Process variable: Any condition associated with the operation of a process, including the quantities and properties of any materials entering or leaving any point in the process, which is, or may readily be, monitored, measured, etc., during the normal course of process operation.

Process weight rate: The process weight charged per unit of time. The term is loosely used interchangeably with operating rate. However, operating rate may cover either input to or output from a process whereas, strictly speaking, process weight rate should cover only material input to a process.

Reactivity: A measure of the rate and extent with which a volatile organic compound will react, in the presence of sunlight and nitrogen oxides, to form photochemical ozone.

RACT (Reasonably Available Control Technology): Reasonable available control technology is defined as the lowest emission limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technical and economic feasibility.

Seasonal adjustment: Used with reference to annual average rates of pollutant emissions, this is the factor needed to calculate daily or hourly average rates for one season (in the case of ozone, summer rates are most commonly required).

SIC Codes (Standard Industrial Classification Codes): A series of codes devised by the Office of Management and Budget to classify establishments according to the type of economic activity in which they are engaged.

SIP (State Implementation Plan) inventories: Emission inventories required as part of the overall State Implementation Plan for achieving the National Ambient Air Quality Standards. States are required under the Clean Air Act to submit these plans to the U.S. Environmental Protection Agency.

Solvent: Any organic compound, generally liquid, that is used to dissolve another compound or group of compounds.

Source: Any person, device, or property that contributes to air pollution.

Source category: Any group of similar sources. For instance, all residential dwelling units would constitute a source category.

Source (process) information: Information collected on each point source in an inventory that describes the source, such as location, fuel use and fuel characteristics, operational data, stack data, or other identifiers. Source information, together with emissions and control device data, comprise the basic elements of an emission inventory. For area sources, this information is usually limited to activity levels.

Source/receptor model: A model or relationship that predicts ambient ozone levels based on precursor emission strengths (of NO_x and VOC) and various meteorological parameters. Source/receptor models may range in complexity from simple empirical or statistical relationships (such as rollback or the Empirical Kinetic Modeling Approach [EKMA]) to detailed photochemical atmospheric simulation models.

Source test: Direct measurement of pollutants in the exhaust stream(s) of a facility.

Spatial resolution: The degree to which the location of a source can be pinpointed geographically within an inventory area.

Species: With regard to VOC, a specific chemical which is part of a particular volatile organic compound, such as methane, 2-hexene, 1,1,1-trichloroethane, etc. With regard to NO_x a species is either nitric oxide (NO) or nitrogen oxide (NO_2).

Species class: Any grouping of VOC compounds, combined in accordance with regulatory policy or rules specified by input instructions for a photochemical simualtion model. Also called "reactive class" or "reactivity class".

Stack parameters: Parameters characteristic of a stack and stack gases, as required for input to some models. Typically included are stack height, inner diameter, volume flow rate, and temperature of gas which are needed to calculate effective stack height (i.e. stack height plus plume rise).

Stationary source: A source which remains at a fixed location while emitting pollutants. Generally, any non-mobile source of air pollutants.

Surface coating: Operations involving the application of paints, varnishes, lacquers, inks, fabric coatings, adhesives, and other coating materials. Emissions of organic compounds result when the volatile portion of the coating evaporates.

Surrogate indicator: (1) For spatial resolution, a quantiy for which distribution over an area is known or accurately estimated which may be assumed similar to the emissions distribution from some source category for which spatial allocation is unknown. (2) For growth, a quantity for which official growth projections are available which may be assumed similar to that of activity in some source category for which projections are needed.

Temporal resolution: (1) The process of determining or estimating what emissions may be associated with various seasons of the year, days of the week or hours of the day, given annual totals or averages. (2) A measure of the smallest time interval with which emissions can be associated in an inventory.

Transportation planning model: A system of computer programs which are used in simulating the performance of existing and future transportation systems in an urban area.

Urban Transportation Planning System: An urban transportation planning battery of computer programs distributed jointly by the Urban Mass Transit Administration and the Federal Highway Administration.

Vehicle miles traveled: An estimated total of number of miles traveled by all vehicles, or by all vehicles of a given category, in a specified region for a specified period of time; often used as a surrogate indicator for spatial resolution of motor vehicle emissions.

Vehicle mix: Composition of vehicular traffic as determined by the fraction of vehicle miles traveled by each class of vehicle.

Volatile organic compounds (VOC): Organic compounds include all compounds of carbon except carbonates, metallic carbides, carbon monoxide, carbon dioxide, and carbonic acid. A volatile organic compound (VOC) is any organic compound that, when released to the atmosphere, can remain long enough to participate in photochemical reactions. While there is no clear line of demarcation between volatile and nonvolatile organics, the predominant fraction of the VOC burden is compounds which evaporate rapidly at ambient temperatures. Almost all organics which can be considered VOC have vapor pressures greater than 0.1 mm of Hg at standard conditions (20°C and 760 mm Hg).

Volume percent: The number of volumes of a given component in 100 volumes of a mixture. In gaseous mixtures, equivalent to mole percent.

Weight percent: The number of weight or mass units of a given component in 100 units of a mixture.

Zone: A subdivision of a study area, constituting the smallest geographic area for which data are aggregated and basic analyses made.

APPENDIX B - POINT SOURCE PROCESS EMISSION REPORTING FORMAT

EPA has proposed that 1982 ozone SIP emission inventories be reported in the formats shown in Table 7.1-1 of Chapter 7 and Figure B-1 of this Appendix.[1] In addition to presenting emissions in the format of Table 7.1-1, point source emissions for each facility are to be reported by process. This appendix will discuss the use of the process emissions listing in Table B-1 and its application to the point source reporting sheet shown in Figure B-1.

Figure B-1 should be used to report VOC emissions by process for an identified point source. Completion of the Name and Location line is self explanatory. The Major VOC Source Category should be listed as the major operation carried out at a facility. For example, a major facility distributing ethanol would be classified under Bulk Gasoline and VOC Terminals in Table B-1. This classification would appear on the Major VOC Source Category line in Figure B-1. The process emission points listed in Table B-1 under this classification (Vapor Collection Losses, Vapor Control Unit Losses, etc.) would appear under Principal Operations in Figure B-1. Emission estimates for these operations would be shown in the right column in Figure B-1 under Emissions.

While these reporting tables are not required for all inventories, use of some type of point source data sheet is recommended. By identifying emissions at the process level, the effect of various control strategies can be better predicted.

Reference for Appendix B

1. Emission Inventory Requirements for 1982 Ozone State Implementation Plans, Draft, EPA-450/4-80-016, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1980.

Principal Emitting Operations at Major VOC Source Categories

Name and Location ____

Major VOC Source Category ______________________________________

Principal Operations	**Emissions**
____________________	__________
____________________	__________
____________________	__________
____________________	__________
____________________	__________
____________________	__________
____________________	__________
____________________	__________
____________________	__________
____________________	__________
____________________	__________
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____________________	__________
____________________	__________
____________________	__________
____________________	__________

Figure B-1. Point Source Process Emission Reporting Sheet.

TABLE B-1.

INDIVIDUAL POINT SOURCE SUMMARY

STORAGE, TRANSPORTATION AND MARKETING OF VOC

- Oil and Gas Production and Processing
  - Storage
  - Fugitives
  - Other Process Units (Specify)

- Tank Farms
  - Fixed Roof Tanks
  - External Floating Roof Tanks
    - Primary Seals
    - Secondary Seals
  - Internal Floating Roof Tanks

- Bulk Gasoline and VOC Terminals
  - Leaks from Valves, Flanges Meters, Pumps
  - Vapor Collection Losses
  - Vapor Control Unit Losses
  - Filling Losses from Uncontrolled Loading Racks
  - Tank Truck Vapor Leaks from Loading of Gasoline
  - Non-Tank Farm Storage

- Gasoline Bulk Plants
  - Gasoline Bulk Storage
  - Loading and Unloading Racks (Controlled and Uncontrolled)
  - Tank Truck Vapor Leaks from Loading and Unloading of Gasoline
  - Leaks from Valves, Flanges, Meters, Pumps

- Barge and Tanker Transfer
  - Gasoline Loading/Barge
  - Crude Oil Ballasting/Tanker

- Barge and Tanker Cleaning

INDUSTRIAL PROCESSES

- Petroleum Refineries
  - Process Drains and Wastewater Separators
  - Vacuum Producing Systems
  - Process Unit Turnarounds
  - Fugitive Leaks from Seals, Valves, Flanges Pressure Relief Devices, Drains
  - Other Process Emissions Such as Heaters, Boilers, Cat Cracker Regenerators (Specify)

- Lube Oil Manufacture

TABLE B-1 (cont.). INDIVIDUAL POINT SOURCE SUMMARY.

- Pharmaceutical Manufacture
    - Process Units Such as Vacuum Dryers, Reactors, Distillation Units, Filters, Extractors, Centrifuges, Crystallizers
    - Major Production Equipment Such as Exhaust Systems and Air Dryers
    - Storage and Transfer
    - Other Process Units (Specify)
- Rubber Tire Manufacture
    - Undertread and Sidewall Cementing
    - Bead Dipping
    - Bead Swabbing
    - Tire Building
    - Tread End Cementing
    - Green Tire Spraying
    - Tire Curing
    - Solvent Mixing
    - Solvent Storage
    - Other Process Units (Specify)
- Styrene Butadiene Rubber Manufacture
    - Blowdown Tanks
    - Steam Stripper
    - Prestorage Tanks
    - Other Process Units (Specify)
- Vegetable Oil
    - Oil Extraction and Desolventization
    - Meal Preparation
    - Oil Refining
    - Fugitive Leaks
    - Solvent Storage
    - Other Process Units (Specify)
- Organic Chemical Manufacture
    - Fugitive Leaks from Seals, Valves, Flanges, Pressure Relief Devices, Drains
    - Air Oxidation Units
    - Waste Water Separators
    - Storage and Transfer
    - Other Process Units (Specify)
- Polymer and Resin Manufacture
    - Catalyst Preparation
    - Reactor Vents
    - Separation of Reactants, Solvents and Diluents from Product
    - Raw Material Storage
    - Solvent Storage
    - Other Process Units (Specify)

TABLE B-1 (cont.). INDIVIDUAL POINT SOURCE SUMMARY.

- Plastic Parts Manufacture
  - Mold Release
  - Solvent Consumption
  - Adhesives Consumption
  - Other Process Units (Specify)

- Inorganic Chemical Manufacture
  - Fugitive Leaks from Seals, Valves, Flanges, Pressure Relief Devices, Drains
  - Storage and Transfer
  - Other Process Units (Specify)

- Fermentation Processes
  - Fermentation Tank Venting
  - Ageing (Wine or Whiskey)
  - Other Process Units (Specify)

- Iron and Steel Manufacture
  - Coke Production
    - Coke Pushing
    - Coke Oven Doors
    - Coke Byproduct Plant
    - Coke Charging
    - Coal Preheater
    - Topside Leaks
    - Quenching
    - Battery Stacks
  - Sintering
  - Electric Arc Furnaces
  - Other Process Units (Specify)

- Synthetic Fiber Manufacture
  - Dope Preparation
  - Filtration
  - Fiber Extrusion - Solvent Recovery
  - Takeup Stretching, Washing, Drying, Crimping, Finishing
  - Fiber Storage - Residual Solvent Evaporation
  - Equipment Cleanup
  - Solvent Storage
  - Other Process Units (Specify)

INDUSTRIAL SURFACE COATING

- Large Appliances
  - Cleaning and Pretreatment
  - Prime Spray, Flow, or Dip Coating Operations
  - Topcoat Spray
  - Coating Mixing
  - Coating and Solvent Storage
  - Equipment Cleanup
  - Other Process Emissions (Specify)

TABLE B-1 (cont.). INDIVIDUAL POINT SOURCE SUMMARY.

Magnet Wire
- Cleaning and Pretreatment
- Coating Application and Curing
- Coating Mixing
- Coating and Solvent Storage
- Equipment Cleanup
- Other Process Emissions (Specify)

Automobiles and Light Duty Trucks
- Cleaning and Pretreatment
- Prime Application, Electro deposition, Dip or Spray
- Prime Surfacting Operations
- Topcoat Operation
- Repair Topcoat Application Area
- Coating Mixing
- Coating and Solvent Storage
- Equipment Cleanup
- Other Process Emissions (Specify)

Cans
- Cleaning and Pretreatment
- Two Piece and Exterior Base Coating
- Interior Spray Coating
- Sheet Basecoating (Interior)
- Sheet Basecoating (Exterior)
- Side Seam Spray Coating
- End Sealing Compound
- Lithography
- Over Varnish
- Coating Mixing
- Coating and Solvent Storage
- Equipment Cleanup
- Other Process Emissions (Specify)

Paper
- Coating Operations
- Coating Mixing
- Coating and Solvent Storage
- Equipment Cleanup
- Other Process Emission (Specify)

Coil Coating
- Prime Coating
- Finish Coating
- Solvent Mixing
- Solvent Storage
- Equipment Cleanup
- Other Process Emissions (Specify)

TABLE B-1 (cont.). INDIVIDUAL POINT SOURCE SUMMARY.

- Fabric
  - Coating Operations
  - Coating Mixing
  - Coating and Solvent Storage
  - Equipment Cleanup
  - Other Process Emissions (Specify)

- Wood Furniture
  - Coating Operations
  - Coating Mixing
  - Coating and Solvent Storage
  - Other Process Emissions (Specify)

- Metal Furniture
  - Cleaning and Pretreatment
  - Coating Operations
  - Coating Mixing
  - Coating and Solvent Mixing
  - Equipment Cleanup
  - Other Process Emissions (Specify)

- Flatwood Products
  - Filler
  - Sealer
  - Basecoat
  - Topcoat
  - Inks
  - Coating Mixing
  - Coating and Solvent Storage
  - Equipment Cleanup
  - Other Process Emissions (Specify)

- Plastic Parts Painting
  - Cleaning and Pretreatment
  - Coating Operations, Flow, Dip, Spray
  - Coating Mixing
  - Coating and Solvent Storage
  - Equipment Cleanup
  - Other Process Emissions (Specify)

- Large Ships
  - Cleaning and Pretreatment
  - Prime Coat Operation
  - Topcoat Operation
  - Coating Mixing
  - Coating and Solvent Storage
  - Equipment Cleanup
  - Other Process Emissions (Specify)

TABLE B1 (cont.). INDIVIDUAL POINT SOURCE SUMMARY.

Large Aircraft
  - Cleaning and Pretreatment
  - Prime Coat Operation
  - Topcoat Operating
  - Coating and Solvent Storage
  - Equipment Cleanup
  - Other Process Emissions (Specify)

Miscellaneous Metal Parts and Products
  - Cleaning and Pretreatment
  - Coating Operations, Flow, Dip, Spray
  - Coating Mixing
  - Coating and Solvent Storage
  - Equipment Cleanup
  - Other Process Emissions (Specify)

OTHER SOLVENT USE

Dry Cleaning

Degreasing
  - Open Top Vapor Degreasing
  - Conveyorized Degreasing - Vapor
  - Conveyorized Degreasing - Cold Cleaning

Solvent Extraction Processes

Adhesives
  - Adhesive Application
  - Solvent Mixing
  - Solvent Storage
  - Other Process Emissions (Specify)

Graphic Arts
  - Letter Press
  - Rotogravure
  - Offset Lithography
  - Ink Mixing
  - Solvent Storage

OTHER SOURCES

Waste Solvent Recovery Processes

APPENDIX C - SUMMARY OF CONTROL TECHNIQUES GUIDELINES

C-1 BACKGROUND

The Clean Air Act Amendments of 1977 require each state having a non-attainment area to adopt and submit a revised State Implementation Plan (SIP) that meets the requirements of Section 110 and Subpart D of the Act. The ozone plan portion of the SIP submissions must contain regulations which reflect the application of reasonably available control technology (RACT) to stationary sources for which control techniques guidelines (CTG) have been published.*

Eleven CTGs, covering 15 VOC source categories, were published prior to January 1978. These first eleven CTGs were:

- Surface Coating of Cans, Coils, Paper, Fabric, Automobiles and Light Duty Trucks (EPA-450/2-77-008).
- Surface Coating of Metal Furniture (EPA-450/2-77-032).
- Surface Coating for Insulation of Magnetic Wire (EPA-450/2-77-033).
- Surface Coating of Large Appliances (EPA-450/2-77-034).
- Storage of Petroleum Liquids in Fixed Roof Tanks (EPA-450/2-77-036).
- Bulk Gasoline Plants (EPA-450/2-77-035).
- Solvent Metal Cleaning (EPA-450/2-77-022).
- Use of Cutback Asphalt (EPA-450/2-77-037).
- Refinery Vacuum Producing Systems, Wastewater Separators and Process Unit Turnarounds (EPA-450/2-77-025).
- Hydrocarbons from Tank Gasoline Loading Terminals (EPA-450/2-77-026).
- Design Criteria for Stage I Vapor Control Systems, Gasoline Service Stations, U.S. EPA, OAQPS, November 1975. Unpublished.

For each source category, a CTG describes the source, identifies the VOC emission points, discusses the applicable control methods, analyzes the costs required to implement the control methods, and recommends regulations for limiting VOC emissions from the source.

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*RACT regulations do not have to be adopted for these stationary sources if a state can demonstrate attainment of the ozone standard.

A document entitled Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources, EPA-905/2-78-001, was published in April 1978. This document provides guidance to the states in preparing RACT regulations for the 15 source categories listed above.

In December 1978, a document entitled Summary of Group I Control Technique Guideline Documents for Control of Volatile Organic Emissions from Existing Stationary Sources, EPA-450/3-78-120, was published. This document provides an overview of the affected source facilities, the magnitude of the VOC emissions from the facilities, and the recommended VOC emission limits.

EPA published an additional 10 CTGs (Group II) in 1978. These 10 source categories covered were:

- Leaks from Petroleum Refinery Equipment (EPA-450/2-78-036).
- Surface Coating of Miscellaneous Metal Parts and Products (EPA-450/2-78-015).
- Manufacture of Vegetable Oil (EPA-450/2-78-035).
- Surface Coating of Flat Wood Paneling (EPA-450/2-78-032).
- Manufacture of Synthesized Pharmaceutical Products (EPA-450/2-78-029).
- Manufacture of Pneumatic Rubber Tires (EPA-450/2-78-030).
- Graphic Arts - Rotogravure and Flexography (EPA-450/2-78-033).
- Petroleum Liquid Storage in External Floating Roof Tanks (EPA-450/2-78-047).
- Perchloroethylene Dry Cleaning Systems (EPA-450/2-78-050).
- Leaks from Gasoline Tank Trucks and Vapor Collection Systems (EPA-450/2-78-051).

A regulatory guidance document was developed from these Group II CTGs. Published in September 1979 and entiled Guidance to State and Local Agencies in Preparing Regulations To Control Volatile Organic Compounds from Ten Stationary Source Categories, EPA-450/2-79-004, this document provides assistance to state and local agencies in preparing RACT regulations for the 10 industrial categories covered by the Group II CTG documents.

In June 1980, EPA began preparation of Control Techniques Guidelines for additional source categories. Identified below are 12 categories for which CTGs will be published in the latter part of 1981. This group will most likely constitute the Group III CTG documents.

- Volatile organic liquid loading into railcars
- Fabric printing
- Volatile organic liquid storage
- Petroleum solvent dry cleaning

- Letterpress printing/offset lithography
- Fugitive VOC, natural gas and natural gasoline processing plants
- Polymers and resins manufacturing
- Fugitive VOC, synthetic organic chemical manufacturing industry (SOCMI)
- Air oxidation, synthetic organic chemical manufacturing industry (SOCMI)
- Styrene butadiene rubber manufacture
- Waste solvent recovery processes[a]
- Architectural surface coatings

[a] May be released later.

In August 1980, EPA began a VOC Source Screening Study. This study will result in the publication of a single document summarizing emission control technology for additional VOC source categories. The VOC source categories listed below will be addressed in this study.

- Adhesives application
- Lubrication oil manufacture
- Barge and tanker cleaning
- Plastics parts painting
- Oil and gas production storage tanks
- Solvent extraction processes
- Asphalt air blowing
- Wine making
- Beer making
- Petroleum coking processes
- Flares - petroleum refineries
- Flares - organic chemical manufacture
- Surface coating - large ships
- Surface coating - large aircraft
- Surface coating - wood furniture

The source categories and publication schedules of the Group III CTGs and the VOC Source Screening Study are tentative and subject to change. For these reasons, agencies should contact EPA Regional offices for additional information.

C-2 GROUPS I & II CTG SUMMARIES

Summaries of Group I and II CTG documents are presented on this appendix for the convience of the reader. These summaries have been extracted directly from two documents developed by EPA's Control Programs Development Division at Research Triangle Park, NC.[1,2] The summaries are intended to present an overview of the affected source facilities, the magnitude of the VOC emissions from the facilities, and the recommended VOC emission limits. More information about the recommended control techniques for an individual source category can be obtained by referring to the specific CTG documents. The regulatory guidance cited previously (EPA-450/2-79-004) discusses areas of difficulty in converting CTG information into regulatory language, a compilation of industry comments on CTG information after conversion into regulatory format, and identification of specific areas of industry concern. For this executive summary, information not available in the CTGs was supplemented with comment from other parties.

References for Appendix C

1. Summary of Group I Control Technique Guideline Documents for Control of Volatile Organic Emissions From Existing Stationary Sources, EPA-450/3-78-120, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1978.

2. Summary of Group II Control Technique Guideline Documents for Control of Volatile Organic Emissions from Existing Stationary Sources, EPA-450/2-80-001, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1979.

Table C-1.

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SUMMARY OF CTG DOCUMENT FOR COATING OF CANS

AFFECTED FACILITIES	Two- and three-piece can surface coating lines including the application areas and the drying ovens.
NUMBER OF AFFECTED FACILITIES	Estimated to be 460 affected facilities nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions from can coating facilities are 140,000 Mg/yr (150,000 ton/yr) which represent about 0.5 percent of the estimated nationwide VOC emissions.
VOC EMISSION RANGE PER FACILITY	Typical annual emissions from can coating lines can vary from 13 Mg (14 tons) for end sealing to 240 Mg (260 ton) for two-piece can coating for a plant average of 310 Mg (340 ton).
100 TON/YR SOURCE SIZE	Typical can coating facilities as represented in the CTG would all approach or exceed 100 TPY VOC emissions if uncontrolled.
CTG EMISSION LIMIT	The recommended VOC emission limits are: a. Sheet coating, two-piece exterior 0.34 kg/l (2.8 lb/gal)* b. Two- and three-piece interior 0.51 kg/l (4.2 lb/gal)* c. Two-piece end exterior 0.51 kg/l (4.2 lb/gal)* d. Three-piece side seam 0.66 kg/l (5.5 lb/gal)* e. End seal compound 0.44 kg/l (3.7 lb/gal)*
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 60 to 100 percent.
COSTS	BASIS: 5,000 scfm facility using thermal or catalytic incineration with primary heat recovery, or adsorption with recovered solvent credited at fuel value. CAPITAL COST: $125,000 - $162,000 ANNUALIZED COST: $42,000 - $71,000 COST EFFECTIVENESS: $135 - $706 per ton VOC

* Coating minus water

Table C-2.

SUMMARY OF CTG DOCUMENT FOR COATING OF METAL COILS

AFFECTED FACILITIES	Coil surface coating lines including the application areas, the drying ovens, and the quench areas.
NUMBER OF AFFECTED FACILITIES	Estimated to be 180 facilities nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions from coil coating facilities are 30,000 Mg/yr (33,000 ton/yr), which represent about 0.1 percent of the estimated nationwide VOC emissions.
VOC EMISSION RANGE PER FACILITY	Average annual VOC emission for a typical facility is estimated to be 180 Mg (200 ton).
100 TON/YR SOURCE SIZE	It is estimated that 2 x $10^6 m^2$ (2 x 10^9 ft^2) of coil coated could result in a potential emission of 100 tons of VOC.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.31 kg per liter of coating minus water (2.6 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 70 to 98 percent.
COSTS	BASIS: 15,000 scfm facility using incineration with primary heat recovery. Capital cost: ≈ \$170,000 Annualized cost: ≈ \$ 70,000 Cost effectiveness: \$51 - \$94 per ton VOC

Table C-3.

SUMMARY OF CTG DOCUMENT FOR COATING OF FABRIC AND VINYL

AFFECTED FACILITIES	Fabric and vinyl surface coating lines including the application areas and the drying ovens. Fabric coating includes all types of coatings applied to fabric. Vinyl coating refers to any printing, decorative, or protective topcoat applied over vinyl coated fabric or vinyl sheets.
NUMBER OF AFFECTED FACILITIES	Estimated to be 130 facilities nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emission from fabric coating operations are 100,000 Mg/yr (110,000 ton/yr). The vinyl segment of the fabric industry emits about 36,000 Mg/yr (40,000 ton/yr). VOC from fabric coating represents about 0.4 percent of the estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Average annual VOC emissions are estimated to be 850 Mg (940 ton).
100 TON/YR SOURCE SIZE	Any but the smallest fabric coating facilities should exceed emissions of 100 ton/yr of VOC.
CTG EMISSION LIMIT	The recommended VOC emission limits are: a. Fabric coating 0.35 kg per liter of coating minus water (2.9 lb/gal). b. Vinyl coating 0.45 kg per liter of coating minus water (3.8 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 80 to 100 percent.
COSTS	BASIS: 15,000 scfm facility using incineration with primary heat recovery or adsorption with recovered solvent credited at fuel value. Capital cost: $150,000 - $320,000 Annualized cost: $ 60,000 - $ 75,000 Cost effectiveness: $34 - $39 per ton VOC

Table C-4.

SUMMARY OF CTG DOCUMENT FOR SURFACE COATING OF PAPER PRODUCTS

AFFECTED FACILITIES	Paper surface coating lines including the application areas and the drying ovens. The CTG document applies to manufacturing of adhesive tapes, adhesive labels, decorated paper, book covers, office copier paper, carbon paper, typewriter ribbons, and photographic films.
NUMBER OF AFFECTED FACILITIES	SIC 2641, Paper Coating and Glazing, had 397 plants in 1967. Current estimates for this category are 290 plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 320,000 Mg/yr (350,000 ton/yr). Of this amount, the manufacture of pressure sensitive tapes and labels is estimated to emit 263,000 Mg/yr (290,000 ton/yr). Emissions from the coating of paper products represent about 1.2 percent of nationwide VOC emissions.
VOC EMISSION RANGE PER FACILITY	Emissions from typical paper coating lines can vary from 23 to 450 kg/hr (50 to 1,000 lb/hr). A plant may have 1 to 20 coating lines. It is estimated that the annual average VOC emission from paper coating plants is 1,480 Mg (1,630 ton).
100 TON/YR SOURCE SIZE	Based on the data given, a plant with one large line or two small lines can exceed 100 ton/yr of VOC emissions.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.35 kg per liter of coating minus water (2.9 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 80 to 99 percent.
COSTS	BASIS: 15,000 scfm facility using incineration with primary heat recovery or adsorption with recovered solvent credited at fuel falue. Capital cost: $150,000 - $320,000 Annualized cost: $ 60,000 - $ 75,000 Cost effectiveness: $34 - $40 per ton VOC

Table C-5.

SUMMARY OF CTG DOCUMENT FOR COATING IN AUTOMOBILE AND LIGHT-DUTY TRUCK ASSEMBLY PLANTS

AFFECTED FACILITIES	Automobile and light-duty truck surface coating lines including the application areas, the flashoff areas, and the drying ovens. The CTG provides no exemptions but notes that it may not be reasonable to convert an existing water-borne dip prime coating system.
NUMBER OF AFFECTED FACILITIES	Identified for the year 1977 to be 47 plants[a] nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions from auto and light duty truck plants are 90,000 Mg/yr (100,000 ton/yr). This is about 0.3 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Emissions from typical coating lines can vary from 270 to 1,600 kg/hr (600 to 4,000 lb/hr). Average annual emissions are estimated to be 2,380 Mg (2,620 ton) per subject plant.
100 TON/YR SOURCE SIZE	All uncontrolled coating lines at the assembly plants are expected to emit in excess of 100 tons of VOC per year.
CTG EMISSION LIMIT	The recommended VOC emission limits are: a. Prime coating 0.23 kg/l (1.9 lb/gal) minus water b. Top coating 0.34 kg/l (2.8 lb/gal) minus water c. Final repair coating 0.58 kg/l (4.8 lb/gal) minus water
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended methods can reduce VOC emissions for: a. Prime coating - 80 to 93 percent. b. Top coating - 75 to 92 percent. c. Final repair coating - not available
COSTS	BASIS: 30 - 65 units per hour facility with substantial variability in both existing operations and potentially applicable control systems. Capital cost: $6,500,000 - $50,000,000 Annualized cost: $2,000,000 - $25,000,000 Cost effectiveness: $1,000 - $4,000 per ton VOC

Table C-6.

SUMMARY OF CTG DOCUMENT FOR COATING OF METAL FURNITURE

AFFECTED FACILITIES	Metal furniture surface coating lines including the application and flashoff areas, and the drying ovens.
NUMBER OF AFFECTED FACILITIES	Approximately 1,400 facilities would be affected nationally.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 90,000 Mg/yr (100,000 ton/yr). This represents about 0.3 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Estimated average annual VOC emissions are 70 Mg (80 ton) per facility.
100 TON/YR SOURCE SIZE	For a model dip coating line, a plant coating (with no primer), 1,500,000 m^2 (16,200,000 ft^2) of shelving per year would emit about 100 ton/yr.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.36 kg per liter of coating minus water (3.0 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 50 to 99 percent.
COSTS	BASIS: A dip coating facility coating 7,000,000 ft^2 of shelving per year converting to water-borne or electrodeposition: Capital cost: $ 3,000 - $124,000 Annualized cost: $11,000 - $ 25,000 Cost effectiveness: $440 - $657 per ton VOC

Table C-7.

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SUMMARY OF CTG DOCUMENT FOR COATING OF MAGNET WIRE

AFFECTED FACILITIES	Wire coating oven.
NUMBER OF AFFECTED FACILITIES	Estimated to be 30 plants nationwide. It is not unusual for a wire coating plant to have 50 coating ovens.
VOC EMISSIONS NATIONWIDE	CTG states that there is no way to know how much solvent is actually emitted. About 29,500 metric tons (32,500 ton) of solvent are used each year but much of this is controlled.
VOC EMISSION RANGE PER FACILITY	Emissions from a typical uncontrolled oven will be approximately 12 kg/hr (26 lb/hr). The average annual emissions of VOC per plant are estimated to be 314 Mg (340 ton)
100 TON/YR SOURCE SIZE	CTG indicates that each of the facilities, if uncontrolled, could easily exceed 100
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.20 kg per liter of coating minus water (1.7 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 90 percent.
COSTS	BASIS: 10,000 scfm facility controlling VOC by use of incineration with primary heat recovery. Capital cost: Approximately $220,000 Annualized cost: $85,000 - $115,000 Cost effectiveness: $105 - $140 per ton VOC

Table C-8.

SUMMARY OF CTG DOCUMENT FOR COATING OF LARGE APPLIANCES

AFFECTED FACILITIES	Large appliance surface coating including the prime, single, or topcoat application areas, the flashoff areas, and the oven.
NUMBER OF AFFECTED FACILITIES	Estimated to be about 270 plants nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 42,000 Mg/yr (46,000 ton/yr) which represent about 0.2 percent of estimated nationwide VOC emissions.
VOC EMISSION RANGE PER FACILITY	The average annual VOC emissions are estimated to be 170 Mg (185 ton).
100 TON/YR SOURCE SIZE	Extrapolating the model facility data, a plant coating 221,000 clothes washer cabinets per year would exceed 100 ton/yr emissions of uncontrolled VOC.
CTG EMISSION LIMIT	The recommended VOC emission limit is 0.34 kg per liter of coating minus water (2.8 lb/gal).
VOC REDUCTION PER FACILITY	The actual percent reduction will vary depending on the solvent content of the existing coatings and the control method selected. Implementation of the recommended control methods can reduce VOC emissions by 79 to 95 percent.
COSTS*	BASIS: 768,000 clothes washer cabinets coated per year using various combinations of control techniques. Capital cost: $70,000 - $1,250,000 Annualized cost: ($300,000) - $350,000 Cost effectiveness: ($1,050) - $1,180 per ton VOC

* ($---) indicates savings

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Table C-9.

SUMMARY OF CTG DOCUMENT FOR TANK TRUCK GASOLINE LOADING TERMINALS

AFFECTED FACILITIES	Any tank truck loading operations at the primary wholesale outlet for gasoline which delivers at least 76,000 liter/day (20,000 gal/day). A facility which delivers under 20,000 gal/day is covered by the CTG for bulk plants.
NUMBER OF AFFECTED FACILITIES	According to the Bureau of Census, there were 1,925 terminals in 1972. Current estimates are about 1,600 terminals nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 250,000 Mg/yr (275,000 ton/yr) which represent about 0.9 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Without vapor recovery systems, VOC emissions can range from 0.6 to 1.4 g/1,000 liters of throughput (5 to 12 lb/1,000 gal). For a typical size facility having a throughput of 950,000 liter/day (250,000 gal/day) VOC emissions are estimated to be 200 Mg/yr (220 ton/yr).
100 TON/YR SOURCE SIZE	For an uncontrolled facility with fixed roof tanks, a 133,000 liter /day (35,000 gal/day) plant would result in VOC emission of 100 ton/yr. For an uncontrolled facility with floating roof tanks, a 454,000 liter/day (120,000 gal/day) facility would result in VOC emissions of 100 ton/yr.
CTG EMISSION LIMIT	The recommended emission limit is 80 mg/liter (0.67 lb/1,000 gal) of gasoline loaded. This limit is based on submerged fill and vapor recovery/control systems. No leaks in the vapor collection system during operation is a requirement.
VOC REDUCTION PER FACILITY	A minimum control of 87 percent is expected for the loading facility.
COSTS	BASIS: 250,000 gal/day facility with active vapor control systems. Capital cost: $140,000 - $195,000 Annualized cost: $ 20,000 - $ 30,000 Cost effectiveness: $120 - $180 per ton VOC

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Table C-10.

SUMMARY OF CTG DOCUMENT FOR BULK GASOLINE PLANTS

<table>
<tr><td>AFFECTED FACILITIES</td><td>A wholesale gasoline distribution facility which has a maximum daily throughput of 76,000 liters (20,000 gal) of gasoline.
Facilities which deliver over 20,000 gal/day are covered under the CTG for terminals. Potentially severe economic hardship may be encountered by bulk plants which deliver less than 4,000 gal/day.</td></tr>
<tr><td>NUMBER OF AFFECTED FACILITIES</td><td>There were 23,367 bulk plants in 1972 according to the Bureau of Census. Current estimates are about 18,000 bulk gasoline plants nationwide.</td></tr>
<tr><td>VOC EMISSIONS NATIONWIDE</td><td>Estimated annual emissions are 150,000 Mg/yr (165,000 ton/yr) which represent about 0.6 percent of estimated VOC emissions nationwide.</td></tr>
<tr><td>VOC EMISSION RANGE PER FACILITY</td><td>A facility with three storage tanks would have VOC emissions approximating 4.4 kg/day (20 lb/day) plus a range of 0.2 to 3.0 g/1,000 liters throughput (2.0 to 25.0 lb/1,000 gal). For a typical size facility having a throughput of 18,900 liter/day (5,000 gal/day) average VOC emissions are estimated to be 15 Mg/yr (17 ton/yr).</td></tr>
<tr><td>100 TON/YR SOURCE SIZE</td><td>None.</td></tr>
<tr><td>CTG EMISSION LIMIT</td><td>Emission limits recommended in terms of equipment specification alternatives:
1. Submerged fill of outgoing tank trucks.
2. Alternative 1 + vapor balance for incoming transfer.
3. Alternative 2 + vapor balance for outgoing transfer.</td></tr>
<tr><td>VOC REDUCTION PER FACILITY</td><td><table>
<tr><th>Emission Reductions</th><th>Total Plant</th><th>All Transfers</th></tr>
<tr><td>Alternative 1</td><td>22 percent</td><td>27 percent</td></tr>
<tr><td>Alternative 2</td><td>54 percent</td><td>64 percent</td></tr>
<tr><td>Alternative 3</td><td>77 percent</td><td>92 percent</td></tr>
</table></td></tr>
<tr><td>COSTS</td><td>BASIS: 4,000 gal/day throughput using submerged fill and vapor balance for both incoming and outgoing transfers.
Capital cost: $4,000 - $10,000
Annualized cost: $ 100 - $ 1,200
Cost effectiveness: $9 - $90 per ton VOC</td></tr>
</table>

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Table C-11.

SUMMARY OF DOCUMENT FOR GASOLINE SERVICE STATIONS - STAGE I

AFFECTED FACILITIES	Transfer of gasoline from delivery trucks to service station storage tanks. No exemptions were noted in the "Design Criteria for Stage I Vapor Control Systems."
NUMBER OF AFFECTED FACILITIES	Estimated to be 180,000 retail gasoline service stations nationwide. There are 240,000 other gasoline dispensing outlets.
VOC EMISSIONS NATIONWIDE	For transfer of gasoline to service station storage tanks, VOC emissions estimated to be 400,000 Mg/yr (440,000 ton/yr) which represents about 1.5 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Without vapor controls, VOC emissions are estimated to be 1.4 kg/1,000 liters (11.5 lb/1,000 gal) of throughput. For a typical facility having a throughput of 151,000 liter/mo (40,000 gal/mo) VOC emissions would be 2.5 Mg/yr (2.8 ton/yr) for Stage I.
100 TON/YR SOURCE SIZE	For an uncontrolled facility, a 2,800,000 liter/mo (750,000 gal/mo) throughput results in VOC emissions of 100 ton/yr. Very few service stations will have this size throughput. The emissions include both Stage I and Stage II losses.
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specifications. Recommended controls are submerged fill of storage tanks, vapor balance between truck and tank, and a leak free truck and vapor transfer system.
VOC REDUCTION PER FACILITY	Stage I control can reduce transfer losses by 95+ percent and total facility losses by 50 percent.
COSTS*	BASIS: Application of submerged fill and vapor balance to a service station with three tanks. Capital cost: $600 Annualized cost: ($200) Cost effectiveness: ($110) per ton VOC

* ($---) indicates savings

Table C-12.

SUMMARY OF CTG DOCUMENT FOR PETROLEUM LIQUID STORAGE IN FIXED-ROOF TANKS

<table>
<tr><td>AFFECTED FACILITIES</td><td colspan="4">Fixed-roof storage tanks having a capacity greater than 150,000 liters (40,000 gal or 950 bbl) and storing petroleum liquids which have a true vapor pressure greater than 10.5 kPa (1.5 psia). Fixed-roof tanks which have capacities less than 1,600,000 liters (420,000 gal or 10,000 bbl) used to store produced crude oil and condensate prior to lease custody transfer are exempt.</td></tr>
<tr><td>NUMBER OF AFFECTED FACILITIES</td><td colspan="4">Estimated for the year 1976 to be 7,300 tanks nationwide.</td></tr>
<tr><td>VOC EMISSIONS NATIONWIDE</td><td colspan="4">Estimated annual emissions are 560,000 Mg/yr (616,000 ton/yr) which represent about 2.1 percent of the estimated VOC emissions nationwide. Emissions of VOC from fixed-roof tanks are 4.7 times that from existing floating roof tanks, although the total capacity of fixed-roof tank storage is less.</td></tr>
<tr><td rowspan="9">VOC EMISSION RANGE PER FACILITY</td><td colspan="4">VOC emission ranges for gasoline or crude oil storage assuming 5 to 20 turnovers per year and a true vapor pressure of 13.8 to 69 kPa (2.0 to 10 psia).</td></tr>
<tr><td>Size →</td><td>Small</td><td>Medium</td><td>Large</td></tr>
<tr><td>Capacity (gal)</td><td>420×10^3</td><td>2.3×10^6</td><td>6.3×10^6</td></tr>
<tr><td>Dimensions
diam. x ht. (ft)</td><td>50 x 30</td><td>100 x 40</td><td>150 x 46</td></tr>
<tr><td>VOC Emissions</td><td></td><td></td><td></td></tr>
<tr><td>Gasoline (Mg/yr)</td><td>12 - 113</td><td>52 - 535</td><td>123 - 1,353</td></tr>
<tr><td>(ton/yr)</td><td>13 - 125</td><td>57 - 590</td><td>135 - 1,490</td></tr>
<tr><td>Crude Oil (Mg/yr)</td><td>7 - 65</td><td>28 - 311</td><td>66 - 796</td></tr>
<tr><td>(ton/yr)</td><td>8 - 72</td><td>30 - 340</td><td>75 - 875</td></tr>
<tr><td>100 TON/YR SOURCE SIZE</td><td colspan="4">Variable depending on many parameters including the type and vapor pressure of the petroleum liquid stored, schedule of tank filling and emptying, and the geographic location of tank. As shown above a medium size tank can easily exceed 100 ton/yr emissions of VOC.</td></tr>
<tr><td>CTG EMISSION LIMIT</td><td colspan="4">Emission limits recommended in terms of equipment specifications: Installation of internal floating roofs or alternative equivalent control. Types of alternative controls are not specified in the CTG document.</td></tr>
<tr><td>VOC REDUCTION PER FACILITY</td><td colspan="4">VOC emission reduction of 90+ percent can be achieved by installation of internal floating roofs.</td></tr>
<tr><td>COSTS*</td><td colspan="4">BASIS: 55,000 bbl (2,310,000 gal) medium size tank with gasoline or crude oil, with true vapor pressure range of 14 to 69 kPa (2 to 10 psia) and 5 to 20 turnovers per year.
Capital cost: $31,000
Annualized cost: $(70,000) to 2,100
Cost effectiveness: ($123) - $73 per ton VOC</td></tr>
</table>

* ($-) indicates savings

Table C-13.

SUMMARY OF CTG DOCUMENT FOR PROCESSES AT PETROLEUM REFINERIES

AFFECTED FACILITIES	The affected facilities and operations are: a. Vacuum producing systems (VPS) b. Wastewater separators (WS) c. Process unit turnarounds (PUT) - (i.e., shutdown, repair or inspection, and start up of a process unit) The CTG provides no exemptions.
NUMBER OF AFFECTED FACILITIES	No estimates of the number of individual facilities are available. There are approximately 285 refineries nationwide.
VOC EMISSIONS NATIONWIDE	Estimated annual nationwide emissions from vacuum producing systems (VPS), wastewater separators (WS), and process unit turnarounds (PUT) are 730,000 Mg/yr (800,000 ton/yr) which represent about 2.7 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	The estimated average annual VOC emissions from affected facilities at a petroleum refinery are 2,560 Mg (2,820 ton). Emission factors used for estimating uncontrolled, reactive VOC emissions are: a. VPS - 145 kg/10^3 m^3 (50 lb/10^3 bbl) refinery throughput b. WS - 570 kg/10^3 m^3 (200 lb/10^3 bbl) refinery throughput c. PUT - 860 kg/10^3 m^3 (301 lb/10^3 bbl) refinery throughput
100 TON/YR SOURCE SIZE	The following annual refinery throughputs will result in 100 ton/yr uncontrolled VOC emissions from each affected facility type: a. VPS - 627 x 10^3 m^3 (3.9 x 10^6 bbl) b. WS - 160 x 10^3 m^3 (1.0 x 10^6 bbl) c. PUT - 105 x 10^3 m^3 (0.67 x 10^6 bbl)
CTG EMISSION LIMIT	Emission limits recommended in terms of equipment specifications: a. VPS - incineration of VOC emissions from condensers b. WS - covering separator forebays c. PUT - combustion of vapor vented from vessels
VOC REDUCTION PER FACILITY	Implementing the recommended controls can reduce VOC emissions by: a. VPS - 100 percent b. WS - 95 percent c. PUT - 98 percent.
COSTS*	BASIS: A 15,900 m^3/day (100,000 bbl/day) refinery using the recommended control equipment. VPS | W S | PUT - 10 units Capital cost $1,000: 24 - 52 | 63 | 98 Annualized cost $1,000: (95) - (89) | (310) | 26 Cost effectiveness $/ton : (104) - (96) | (90) | 5

* ($-) indicates savings

Table C-14.

SUMMARY OF CTG DOCUMENT FOR CUTBACK ASPHALT

AFFECTED FACILITIES	Roadway construction and maintenance operations using asphalt liquefied with petroleum distillates.
NUMBER OF AFFECTED FACILITIES	No estimates were obtained.
VOC EMISSIONS NATIONWIDE	Estimated annual emissions are 655,000 Mg/yr (720,000 ton/yr). This represents about 2.4 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Estimated VOC emissions from cutback asphalt production are: a. 0.078 kg/kg (ton/ton) of slow cure asphalt. b. 0.209 kg/kg (ton/ton) of medium cure asphalt. c. 0.204 kg/kg (ton/ton) of rapid cure asphalt.
100 TON/YR SOURCE SIZE	Not generally applicable to this source category since the main sources of emissions are the road surfaces where the asphalt is applied.
CTG EMISSION LIMIT	Substitute water and nonvolatile emulsifier for petroleum distillate blending stock.
VOC REDUCTION PER FACILITY	VOC emission reductions are approximately 100 percent.
COSTS*	BASIS: The major cost associated with control of VOC is the price difference between cutback and emulsified asphalt. A price differential of 5 cent/gallon savings to 1 cent/gallon penalty results in a cost effectiveness range of ($73) - $15 per ton VOC.

* ($---) indicates savings

Table C-15.

SUMMARY OF CTG DOCUMENT FOR SOLVENT METAL CLEANING

AFFECTED FACILITIES	Three types of solvent degreasers are affected: a. Cold cleaner: batch loaded, nonboiling solvent degreaser. b. Open top vapor degreaser: batch load, boiling solvent degreaser. c. Conveyorized degreaser: continuously loaded, conveyorized solvent degreaser, either boiling or nonboiling. Open top vapor degreasers smaller than 1 m^2 of open area are exempt from the application of refrigerated chillers or carbon adsorbers. Conveyorized degreasers smaller than 2.0 m^2 of air/vapor interface are exempt from a requirement for a major control device.
NUMBER OF AFFECTED FACILITIES	Estimates of the number of solvent degreasers nationwide for the year 1974 are: a. Cold cleaners (CC) - 1,220,000. b. Open top vapor degreasers (OT) - 21,000. c. Conveyorized degreasers (CD) - 3,700.
VOC EMISSIONS NATIONWIDE	Estimates of annual nationwide emissions are: a. CC - 380,000 Mg/yr (419,000 ton/yr). b. OT - 200,000 Mg/yr (221,000 ton/yr) c. CD - 100,000 Mg/yr (110,000 ton/yr) which represent about 2.5 percent of estimated VOC emissions nationwide.
VOC EMISSION RANGE PER FACILITY	Averaged emission rates per degreaser: a. CC - 0.3 Mg/yr (0.3 ton/yr). b. OT - 10 Mg/yr (11 ton/yr). c. CD - 27 Mg/yr (30 ton/yr).
100 TON/YR SOURCE SIZE	Data indicate that on an average 10 open top degreasers or 4 conveyorized degreasers may emit 100 ton/yr.
CTG EMISSION LIMIT	The VOC emission limit is recommended in terms of equipment specifications and operation procedures. Required control equipment can be as simple as a manually operated tank cover or as complex as a carbon adsorption system depending on the type, size, and design of the degreaser.
VOC REDUCTION PER FACILITY	The actual percent VOC reduction will vary depending on the control equipment installed and the operational procedures followed. Recommended control methods can reduce VOC emissions by: a. CC - 50 to 53 percent (+ 20 percent). b. OT - 45 to 60 percent (± 15 percent). c. CD - 25 to 60 percent (± 10 percent).
COSTS *	BASIS: CC of 0.5 m^2 work area using high volatility solvent (a) and low volatility solvent (b); OT of 1.67 m^2 work area; and CD of 3.9 m^2 work area.

	Capital Cost $1,000	Annualized Cost $1,000	Cost Effectiveness $/ton VOC
CC-a	0.025	0.001	20
CC-b	0.065	(0.026)	(240)
OT	0.3 - 10.3	(0.8) - 0.8	(360) - 220
CD	7.5 - 18	(3.7) - 1.5	(260) - 260

* ($---) indicates savings

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Table C-16.

SUMMARY OF CTG DOCUMENT FOR SURFACE COATING OF MISCELLANEOUS METAL PARTS AND PRODUCTS

Affected facilities (p. 1-2)*	Coating application areas, flashoff areas, dryers, and ovens for manufacturers of: a. Large farm machinery b. Small farm machinery c. Small appliances d. Commercial machinery e. Industrial machinery f. Fabricated metal products g. Any other industrial category, which coats metals, under SIC major groups 33-39, inclusive. Except those facilities which are covered by previous CTGs.
Number of affected facilities	96,000
VOC emissions nationwide	9.0×10^5 Mg/yr (1×10^6 tons/yr) estimated for 1977, which represents about 5.0 percent of stationary source estimated emissions.
VOC emission range per facility (pp. 1-10, 2-3)*	a. An emission factor of 0.66 kg VOC/l coating less water (5.5 lb VOC/gal coating less water) can be expected from a facility utilizing a coating composed of 75 percent organic solvent, 25 percent solids by volume. b. For facilities utilizing an electrodeposition process the VOC emission factor is 0.36 kg VOC/l coating less water (3.0 lb/gal).
100 tons/yr source size (calculated)	An emission factor of 5.5 lb VOC/gal implies that a minimum process rate of 3.64×10^4 gal coating material/yr would be required for a facility to be a potential 100 tons/yr source.
CTG emission limit (p. v)*	Coating method — Recommended limitation $\frac{\text{wt. VOC}}{\text{vol. coating}}$ a. Air or forced air dried items — 0.42 kg/l (3.5 lb/gal) b. Clear coat — 0.52 kg/l (4.3 lb/gal) c. No or infrequent color change or small number of colors applied 1. Powder coatings — 0.05 kg/l (0.4 lb/gal) 2. Other — 0.36 kg/l (3.0 lb/gal) d. Outdoor, harsh exposure or extreme performance characteristics — 0.42 kg/l (3.5 lb/gal) e. Frequent color change, large number of colors applied, or first coat on untreated ferrous substrate — 0.36 kg/l (3.0 lb/gal)
VOC reduction per facility (p. 2-1)*	Percent reduction in VOC emissions Process modification (coating/equipment change) 50-98 Exhaust gas treatment 90+
Costs (pp. 3-8 to 3-14)*	Basis: A medium size coating line (~ 743,000 m^2/yr, ~ 8×10^6 ft^2/yr) with single or two coat operation using flow-coat, dip-coat, or spray-coat applications. The ranges cover the cots of several different VOC control options. Capital cost ($1000) 20-1,837 Annualized cost ($1000) (27)†-602 Cost effectiveness ($/Mg) (290)†-6,841 ($/ton) (263)†-6,206

*The source of the summary information is the indicated page number in "Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VI: Surface Coating of Miscellaneous Metal Parts and Products," EPA-450/2-78-015.

†Numbers in parentheses are savings.

Table C-17.

SUMMARY OF CTG DOCUMENT FOR FACTORY SURFACE COATING OF FLAT WOOD PANELING

<table>
<tr><td>Affected facilities (p. 1-2)*</td><td colspan="5">The affected facilities are factories that surface coat the following types of flat wood panels:
a. Hardwood plywood
b. Particleboard
c. Hardboard</td></tr>
<tr><td>Number of affected facilities (p. 1-2)*</td><td colspan="5">Affected Facilities — Nationwide Total
a. Hardwood plywood — 247
b. Particleboard — 80
c. Hardboard — 67</td></tr>
<tr><td>VOC emissions nationwide</td><td colspan="5">8.4×10^4 Mg/yr (9.3×10^4 tons/yr) estimated for 1977 which represents about 0.5 percent of stationary source estimated emissions.</td></tr>
<tr><td>VOC emission range per facility (Table 2-2 p. 2-5)*</td><td colspan="5">Potential VOC emissions per coated surface area are:
0.4 to 8.0 kg/100 m^2 (0.8 to 16.5 lb/1000 ft^2)
depending on the coating/curing process as well as the coating materials used.</td></tr>
<tr><td>100 tons/yr source size (calculated)</td><td colspan="5">Based on the VOC emission range above, a 100 tpy source would cost a minimum annual throughput of:
3.8×10^5 to 7.7×10^6 standard panels/yr
Where a standard panel is 2.97 m^2 (32 ft^2).</td></tr>
<tr><td>CTG emission limit (p. v)*</td><td colspan="5">Recommended limitation
Printed hardwood plywood and particleboard — 2.9 kg VOC/100 m^2 (6.0 lb VOC/1000 ft^2)
Natural finish hardwood plywood — 5.8 kg VOC/100 m^2) (12.0 lb VOC/1000 ft^2)
Class II[†] finishes for hardboard paneling — 4.8 kg VOC/100 m^2) (10.0 lb VOC/1000 ft^2)</td></tr>
<tr><td>VOC reduction per facility (Table 2-1 p. 2-4)*</td><td colspan="5">70 to 90 percent VOC emission reduction, depending on coating material and coverage, through use of water-borne coatings, incineration, adsorption, ultraviolet curing or electron beam curing.</td></tr>
<tr><td rowspan="6">Costs (Table 3-2 p. 3-9)*</td><td colspan="5">Basis:</td></tr>
<tr><td>Shifts:</td><td colspan="2">1</td><td colspan="2">2</td></tr>
<tr><td>Panels/yr:</td><td colspan="2">2,000,000</td><td colspan="2">4,000,000</td></tr>
<tr><td></td><td>Waterborne</td><td>UV/Waterborne</td><td>Waterborne</td><td>UV/Waterborne</td></tr>
<tr><td>Capital cost ($1000)
Annualized cost ($1000)</td><td>52
101</td><td>155
124.6</td><td>52
200.8</td><td>155
234.4</td></tr>
<tr><td>Cost effectiveness
($/Mg)
($/ton)</td><td>
269
244</td><td>
292
264</td><td>
256
232</td><td>
264
240</td></tr>
</table>

*The source of the summary information is the indicated page number in "Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VII: Factory Surface Coating of Flat Wood Paneling," EPA-450/2-78-032.

[†] Definition on p. vii of EPA-450/2-78-032.

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Table C-18.

SUMMARY OF CTG DOCUMENT FOR MANUFACTURE OF SYNTHESIZED PHARMACEUTICAL PRODUCTS

Affected facilities (p. 1-4)*	Synthesized pharmaceutical manufacturing facilities. Specific sources include: 1. Dryers 2. Reactors 3. Distillation Units 4. Storage and transfer of VOC 5. Filters 6. Extraction equipment 7. Centrifuges 8. Crystallizers.
Number of affected facilities (p. 1-2)*	Estimated 800 plants nationwide
VOC emissions nationwide	50,000 Mg/yr (55,000 tons/yr) estimated for 1977 which represents about 0.3 percent of stationary source estimated VOC emissions.
VOC emission range per facility	Not available
100 ton/yr source size	Not available
CTG emission limit (p. 1-5)*	1. a. Surface condensers or equivalent control on vents from reactors, distillation operations, crystallizers, centrifuges, and vacuum dryers that emit 6.8 kg/day (15 lb/day) or more VOC. b. Surface condensers must meet certain temperature versus VOC vapor pressure criteria. 2. Additional specific emission reductions are required for air dryers, production equipment exhaust systems, and storage and transfer of VOC. 3. Enclosures or covers are recommended for rotary vacuum filters, processing liquid containing VOC and in-process tanks. 4. Repair of components leaking liquids containing VOC.
VOC reduction per facility	Not available
Costs (pp. 5-14 to 5-42)*	Capital and Annualized Cost graphs are provided for the following types of control equipment: conservation vents, floating roofs, pressure vessels, carbon adsorption systems, thermal and catalytic incineration systems, water cooled condensers, chilled water and brine cooled condensers, freon cooled condensers, packed bed scrubbers and venturi scrubbers. Cost effectiveness data is not calculated for typical plants.

*The source of the summary information is the indicated page(s) in "Control of Volatile Organic Emissions from Manufacture of Synthesized Pharmaceutical Products," EPA-450/2-78-029.

Table C-19.

SUMMARY OF CTG DOCUMENT FOR MANUFACTURE OF PNEUMATIC RUBBER TIRES

Affected facilities (pp. 1-1, 1-3) *	**Rubber tire manufacturing plants, producing passenger car, and light and medium duty truck tires. Operations affected are: undertread cementing, bead dipping, tread end cementing, and green tire spraying.**
Number of affected facilities (p. 2-2) *	**Maximum of 62 rubber tire plants nationwide**
VOC emissions nationwide (p. 1-2) *	**1976 VOC emissions estimate from rubber tire manufacturing totalled 88,200 Mg/yr (97,200 tons/yr). This quantity represents 0.6 percent of total national VOC emissions from stationary sources.**
VOC emission range per facility (p. 1-2) *	**The average tire plant is estimated to release 4,000 kg per day (8,820 lb/day) of emissions or 1,000 Mg VOC per year (1,100 tons/yr).**
100 tons/yr source size (p. 2-8) *	The model plant, producing 16,000 tires/day, has potential to emit 1,460 Mg/yr (1,600 tons VOC/yr). Therefore a plant producing approximately 1,000 tires/day would be a potential 100 tons/yr source.
CTG emission limit (p. 4-2) *	VOC emissions reduction from the affected operations is recommended through use of carbon adsorption or incineration. Water-based coatings may be used for green tire spraying.
VOC reduction per facility (p. 1-4) *	a. Carbon adsorption gives an overall efficiency of 62-86 percent in reducing VOC emissions, when applied to the affected operations. b. Incineration gives an overall efficiency of 59-81 percent when applied to the affected operations. c. Water-based coatings, applied to green tire spraying, provide an overall emission reduction efficiency of 97 percent.
Costs (pp. 4-11, 4-15) *	Basis: A model 16,000 tires/day plant using the various control technologies recommended on the following affected operations. All costs are based on January 1978 dollars.

	Undertread cementing	Bead dipping	Tread end cementing	Green tire spraying
Capital cost ($1000)	130-340	115-250	135-375	15-450
Annualized cost ($1000)	92-280	70-985	100-340	118-490
Cost effectiveness				
($/Mg)	166-505	1,480-20,800	1,140-3,880	202-839
($/ton)	150-458	1,340-18,800	1,000-3,500	184-763

*The source of the summary information is the indicated page(s) in "Control of Volatile Organic Emissions from Manufacture of Pneumatic Rubber Tires," EPA-450/2-78-030.

Table C-20.

SUMMARY OF CTG DOCUMENT FOR GRAPHIC ARTS — ROTOGRAVURE AND FLEXOGRAPHY

<table>
<tr><td>Affected facilities (p. 1-1)*</td><td colspan="5">Flexographic and rotogravure processes applied to publication and packaging printing.</td></tr>
<tr><td>Number of affected facilities (p. 2-5)*</td><td colspan="5">a. Publication printing is done in large printing plants, numbering less than 50 in total.
b. There are approximately 13 to 14 thousand gravure printing units and 30 thousand flexographic printing units.</td></tr>
<tr><td>VOC emissions nationwide (p. 2-8)*</td><td colspan="5">a. Gravure 100,000 Mg/yr 1976 (110,000 tons/yr)
b. Flexography 30,000 Mg/yr 1976 (33,000 tons/yr)
This represents about 0.8 percent of stationary source estimated emissions.</td></tr>
<tr><td>VOC emission range per facility (calculated)</td><td colspan="5">a. Gravure 7.4 Mg/printing unit per year (8.2 tons/unit)
b. Flexography 1 Mg/printing unit per year (1.1 tons/printing unit per year)</td></tr>
<tr><td>100 tons/yr source size</td><td colspan="5">A plant will be a potential 100 tons/yr VOC source if it uses 110-180 Mg (120-200 tons) of ink per year, where the solvent concentration is 50-85 percent.</td></tr>
<tr><td>CTG emission limit (pp. 1-2, 1-3)*</td><td colspan="5">Use of water-borne or high solids inks meeting certain composition criteria or the use of capture and control equipment which provides:
a. 75 percent overall VOC reduction where a publication rotogravure process is employed;
b. 65 percent overall VOC reduction where a packaging rotorotogravure process is employed; or,
c. 60 percent overall VOC reduction where a flexographic printing process is employed.</td></tr>
<tr><td>VOC reduction per facility</td><td colspan="5">Same as CTG limit above.</td></tr>
<tr><td>Costs (pp. 4-8 4-13)*</td><td>VOC control option</td><td>Incinerator</td><td>Incinerator</td><td>Carbon adsorption</td><td>Carbon adsorption</td></tr>
<tr><td></td><td>Ink usage, Mg/yr
(tons/yr)</td><td>7
(7.7)</td><td>2,500
(2,750)</td><td>3,500
(3,860)</td><td>7,000
(7,720)</td></tr>
<tr><td></td><td>VOC concentration ppm</td><td>500</td><td>500</td><td>1,200</td><td>2,400</td></tr>
<tr><td></td><td>Capital cost</td><td>94,000</td><td>1,110,000</td><td>701,000</td><td>701,000</td></tr>
<tr><td></td><td>Annualized cost</td><td>24,900</td><td>1,665,500</td><td>72,800</td><td>(41,700)[†]</td></tr>
<tr><td></td><td>Cost effectiveness
$/Mg
$/ton</td><td>
8,360
7,570</td><td>
1,650
1,480</td><td>
51
46</td><td>
(15)[†]
(13)[†]</td></tr>
</table>

*The source of the summary information is the indicated page number in "Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VIII: Graphic Arts -- Rotogravure and Flexography," EPA-450/2-78-033.

[†] Numbers in parentheses are savings.

Table C-21.

SUMMARY OF CTG DOCUMENT FOR PERCHLOROETHYLENE DRY CLEANING SYSTEMS

Affected facilities (p. 2-1)*	Affected facilities are coin-operated, commercial, and industrial dry cleaning systems which utilize perchloroethylene as solvent.
Number of affected facilities (calculated)	a. Coin-op 14,900 b. Commercial 44,600 c. Industrial 230
VOC emissions nationwide (pp. 1-2, 2-1)*	a. Coin-op 21,400 Mg/yr (23,500 tons/yr) b. Commercial 123,000 Mg/yr (135,000 tons/yr) c. Industrial 13,600 Mg/yr (15,000 tons/yr) The estimated 158,000 Mg VOC/yr is 0.9 percent of total stationary source estimated emissions.
VOC emission range per facility (p. 5-2)*	Uncontrolled VOC emissions Type of plant — kg/yr — (lb/yr) a. Coin-op — 1,460 — (3,200) b. Commercial — 3,240 — (7,200) c. Industrial — 32,400 — (72,000)
100 tons/yr source size (extrapolated)	A large industrial dry cleaning plant, processing 750 Mg (825 tons) of clothes per year, would be a potential 100 tons VOC per year source.
CTG emission limit (pp. 6-1 – 6-4)*	a. Reduction of dryer outlet concentration to less than 100 ppm VOC, by means of carbon adsorption. (Facilities with inadequate space or steam capacity for adsorbers are excluded.) b. Reduction of VOC emissions from filter and distillation wastes. c. Eliminate liquid and vapor leaks.
VOC reduction per facility (pp. 2-5, 2-7)*	Carbon adsorption applied to commercial and industrial plants will reduce overall VOC emissions by 40-75 percent.
Costs (p. 4-5)*	Basis: Carbon adsorbers for a commercial plant cleaning 46,000 kg (100,000 lb) of clothes per year. Capital cost $4,500 Annualized cost $300 Cost effectiveness $90 credit/Mg $80 credit/ton

*The source of the summary information is the indicated page number in "Control of Volatile Organic Emissions from Perchloroethylene Dry Cleaning Systems," EPA-450/2-78-050.

Table C-22.

SUMMARY OF CTG DOCUMENT FOR LEAKS FROM PETROLEUM REFINERY EQUIPMENT

Affected facilities (p. 6-1)*	Petroleum refinery equipment including pump seals, compressor seals, seal oil degassing vents, pipeline valves, flanges and other connections, pressure relief devices, process drains, and open ended pipes.
Number of affected facilities	There were 311 petroleum refineries in the nation as of January 1, 1979.
VOC emissions nationwide (p. 5-1)*	The estimated VOC emissions nationwide are 170,000 Mg/year, or about 1 percent of the total VOC emissions from stationary sources.
VOC emissions range per facility (p. 3-2)*	The potential VOC emissions per leaking source range from 1.0 to 10 kg/day.
100 ton/year source size (p. 1-3, 2-3)*	A single leaking source has the potential to emit 0.4 to 3.7 Mg VOC/year (0.5 to 4.1 ton/yr). A refinery with between 25 and 227 leaking components would emit 100 tons/year of VOC. A model medium size refinery may have 90,000 leaking components.
CTG emission limits (p. 1-3)*	If a leaking component has a VOC concentration of over 10,000 ppm at the potential leak source, it should be scheduled for maintenance and repaired within 15 days.
VOC reduction per facility (calculated)	Estimated to prevent the release of 1821.1 Mg/year (2007.4 ton/year) of VOC at a model medium size refinery (15,900 m^3/day) by reducing emissions from 2933.6 Mg (3233.5 ton) to 1112.5 Mg (1226.1 ton) per year
Costs (p. 4-8)*	Basis: A monitoring and maintenance program for a 15,900 m^3/day (100,000 bbl/day) refinery (Fourth quarter 1977 dollars). Instrumentation Capital Cost 8,800 Total Annualized Costs 115,000 Cost Effectiveness $/Mg (86.85)† $/ton (78.81)†

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*The source of the summary information is the indicated page number(s) in "Control of Volatile Organic Compound Leaks from Petroleum Refinery Equipment," EPA-450/2-78-036.

†Numbers in parentheses are savings.

Table C-23.

SUMMARY OF CTG DOCUMENT FOR EXTERNAL FLOATING ROOF TANKS

Affected facilities (p. 1-2)*	External floating roof tanks larger than 150,000 liters (40,000 gal) storing petroleum liquids. See exceptions noted in text.
Number of affected facilities (p. 2-1)*	There is an estimated 13,800 internal and external floating roof tanks that are larger than 150,000 liters (40,000 gal). The number of external floating roof tanks is not available.
VOC emissions nationwide (p. 1-2)*	An estimated 65,000 Mg (71,630 tons) of VOC was emitted in 1978 which represents about 4.0 percent of stationary source estimated emissions.
VOC emission range per facility (pp. 3-3, 3-9)*	The emission range for a 30.5 m (100 ft) diameter tank storing 41.4 kPa (6 psi) vapor pressure gasoline is 212 Mg/yr (233 tons/yr) for a slightly gapped primary seal to 2.2 Mg/yr (2.4 tons/yr) for a tight rim-mounted secondary seal over a tight primary seal.
100 tons/yr source size	No single floating roof tank is expected to emit more than 100 tons/yr.
CTG emission limit (pp. 5-1, 5-4)*	A continuous secondary seal or equivalent closure on all affected storage tanks, plus certain inspection and recordkeeping requirements.
VOC reduction per facility (pp. 3-3, 3-9)*	Ranges from about 200 to 2 Mg/yr (220 to 2.2 tons/yr).
Costs (pp. 4-9, 4-12)*	Basis: External floating roof tank 30.5 m (100 ft) in diameter with a capacity of 8.91 × 10^6 liters (55,000 bbl) controlled by a rim mounted secondary seal. Capital cost ($1000) 16.9 Annualized cost ($1000) 3.3 Cost effectiveness ($/Mg) (66)†-3,655 ($/ton) (59)†-3,316

*The source of the summary information is the indicated page(s) in "Control of Volatile Organic Emissions from Petroleum Liquid Storage in External Floating Roof Tanks," EPA-450/2-78-047.

†Numbers in parenthesis indicate credits.

Table C-24.

SUMMARY OF CTG DOCUMENT FOR LEAKS FROM GASOLINE TANK TRUCKS AND VAPOR COLLECTION SYSTEM

Affected facilities (p. 2)*	a. Gasoline tank trucks that are equipped for vapor collection. b. Vapor collection systems at bulk terminals, bulk plants, and service stations that are equipped with vapor balance and/or vapor processing systems.
Number of affected facilities	Not available
VOC emissions nationwide	Not available
VOC emission range per facility	Not available
CTG emission limit (pp. 1 and 2)	The control approach is a combination of testing, monitoring, and equipment design to ensure that good maintenance practices are employed to prevent leaks from truck tanks or tank compartments and vapor collection systems during gasoline transfer at bulk plants, bulk terminals, and service stations. A leak is a reading greater than or equal to 100 percent of the LEL at 2.5 cm from a potential leak source as detected by a combustible gas detector.
VOC reduction per facility	Not available
Costs	Not available

*The source of the summary information is the indicated page number in "Control of Volatile Organic Compound Leaks from Gasoline Tank Trucks and Vapor Collection Systems," EPA-450/2-78-051.

APPENDIX D - EXAMPLE QUESTIONNAIRES

A general discussion of the design and use of questionnaires is presented in Chapter 3. This appendix contains example questionnaires for inventorying VOC emissions from solvent use. The inclusion of these questionnaires does not imply an endorsement by EPA or a requirement to use them. They are presented merely to show basic structure, possible content, and various alternatives available.

Additional example questionnaires and background discussion on questionnaire development are available in Reference 1. These questionnaires are also not required or endorsed by EPA. The reader is simply referred to the document for additional information.

The primary consideration in developing questionnaires is the inventory agency's data requirements. The agency's needs will determine whether to use general or industry-specific questionnaires and what data to elicit. Discussion on general versus industry-specific questionnaires is included in both Chapter 3 and Reference 1.

The reader is reminded to observe several caveats when reviewing the questionnaires in this Appendix. Note that industry-specific questionnaires must be developed for refineries, chemical manufacturers, and some other sources. For a VOC emissions inventory, each questionnaire design should be consistent with the data requirements of emission factors in AP-42, CTG documents, or any other references. These references should be reviewed during the development of questionnaires. In addition, local or state regulations should be consulted before mailing questionnaires to ensure that all clearance requirements for the forms are met. For example, EPA questionnaire forms must be approved by the Office of Management and Budget prior to release to more than ten sources. Finally, the reader is reminded to note the caveats mentioned in Chapter 3.

Reference for Appendix D

1. Development of Questionnaires for Various Emission Inventory Uses, EPA-450/3-78-122, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1979.

[Agency Letterhead]

Mailing
Label

Dear Sir(s):

The (agency or department) requests your cooperation in providing the information described on the enclosed questionnaire. The data provided will be evaluated along with information being gathered from other sources to determine the impact of hydrocarbon and nitrogen oxide emissions on the air quality in (geographical area). This request is being made under (statute) which allows information to be required from sources of air pollution. In addition, the more nearly complete and accurate the response to the questionnaire, the more valid the conclusion of the study will be.

Certain emission-related data on your equipment or processes have been extracted from available records. The information requested on the enclosed forms is not available from current agency records and is needed to assess base line emissions, control potential, and to project future emissions. Please complete the enclosed questionnaire and return it within (time period) to the address indicated on the form.

Any questions regarding these forms should be directed to

(name, address, phone number)

Your cooperation in providing the requested information within (number) days from receipt of this letter will contribute materially to the accurate assessment of emissions in (area). Thank you for your assistance.

Sincerely,
(name and title)

Enclosures

Figure D-1. Example Cover Letter.

GENERAL INSTRUCTION

ORGANIC SOLVENT SOURCE QUESTIONNAIRE

1. All questions should be directed to (name, address, phone number)

2. This questionnaire is aimed at obtaining information from a wide variety of solvent users. The complete questionnaire includes the following pages:

   Page A - GENERAL INFORMATION
   B - DEGREASING OPERATIONS
   C - DRY CLEANING OPERATIONS
   D - PROTECTIVE OR DECORATIVE COATINGS
   E - FABRIC OR RUBBERIZED COATINGS
   F - MISCELLANEOUS SURFACE COATINGS
   G - OVENS
   H - PRINTING
   I - GENERAL SOLVENT USE
   J - BULK SOLVENT STORAGE
   K - CONTROL AND STACK INFORMATION

3. Data should reflect calendar year (year) or whichever is more readily available. Specify any other 12-month period that may be used.

4. Fill in the descriptive information and amount of solvent or solvent containing materials used for each device operating under county permit as shown in the example on each page. (Note: these examples are for illustration only and may not represent actual operating conditions.)

5. In the event that data are not available on an individual device basis, use best estimates from total plant usage to complete Item 4.

6. If the type(s) and/or percentages of solvents in coatings, inks, etc. are not known, include sufficient information on the manufacturer, type and stock number so that this breakdown can be obtained. A copy of a supplier's invoice would be adequate.

7. Complete Pages I, J and K.

8. The emissions data that will be generated during this program will generally be public information. If certain process, operation, or material information is considered confidential and should be considered a trade secret, indicate such (specify a procedure and specify how confidential data will be handled).

Figure D-2. Example Questionnaire-Instruction Sheet.

ORGANIC COMPOUND EMISSIONS QUESTIONNAIRE

Mail Questionnaires in the Enclosed Envelope To:

Please Address All Questions To:

NOTE: ALL DATA SHOULD REPRESENT CALENDAR YEAR

GENERAL INFORMATION

Company Name ________________________________

Plant Address ________________ City ____________ Zip ______

Mailing Address ________________ City ____________ Zip ______

Person to Contact About Form ________________________

Telephone ______________ Title ___________________

Approximate Number of Employees ______

Nature of Business (Include SIC) ______________________

____

Normal Operating Schedule for Calendar Year ______

________ Hrs/Day ________ Days/Week ________ Weeks/Year

Approximate Percent Seasonal Operation:

Dec.-Feb.	Mar.-May	June-Aug.	Sept.-Nov.

Are hydrocarbon or organic solvent containing materials such as cleaning fluids, coatings, adhesives, inks, etc. used in your operation?

_____ Yes _____ No If yes, please complete the appropriate forms enclosed. Make additional copies if necessary. If organic solvents are not in use please sign and return.

____________________ ____________________

Signature Date

Figure D-3. Example Questionnaire-General Information Page.

DEGREASING OPERATIONS

1. Materials Processed ______________

2. Type and Amount of Solvents Used:

County Permit Number	Type of Degreasing*	Type(s) of Solvents Employed†	Amount of Solvents Added (Gal/Yr)	Amount of Solvent Removed for Reprocessing (Gal/Yr)	Normal§ Operating Hr	Day	Week
EXAMPLE P99999	Vapor	Perc	2000	500	8	5	50

*Cold cleaning, vapor degreasing

†Stoddard, 1,1,1, trichloroethane, perchloroethylene, methyl chloride, trichloroethylene, other (specify.)

§Normal operating period - hrs/day, days/wk, and wk/yr. .If the approximate percent seasonal operation differs from that on Page A, please indicate.

Figure D-4. Example Questionnaire-Degreasing Operations Form.

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DRY CLEANING

1. Material Being Cleaned: ____________________

2. Type and Amount of Cleaning:

County Permit Number	Amount of Clothes Cleaned (Tons/Yr)	Type of Cleaning*	Type(s) of Cleaning Solvents†	Amount (Gal/Yr)	Normal§ Operating Hr	Day	Week
EXAMPLE P99999	2000	Hot	Perc	2000	8	5	50

*Hot unit (washing/extraction/drying in one machine) or transfer unit (use of a separate recovery tumbler)

†Perchlorethylene, Stoddard, other (specify)

§Normal operating period - hrs/day, days/wk, and wk/yr. If the approximate percent seasonal operation differs from that on Page A, please indicate.

Figure D-5. Example Questionnaire-Dry Cleaning Form.

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PROTECTIVE OR DECORATING COATINGS

1. Materials Coated ____________________

2. Type and Amount of Coating Used:

County Permit Number	Application Method*	Type of Coating†	Amount of Coating (Gal/Yr)	Type and % of Major Solvents‡		Type and Amount of Solvents Added (Gal/yr)		Method of Drying- (Air, Heat Treated)	Normal Operating§		
									Hr	Day	Week
EXAMPLE P99999	Spray	Enamel	2000	MEK	60 %	Toluene	200	Oven	8	5	50

3. Type of Cleaning Solvent: ____________________, Amount ________ (Gal/Yr)

[*] Spray, dip, roller, flow, etc.

[†] Paint, varnish/shellac, lacquer, enamel, primer

[‡] Acetone, isopropyl alcohol, MEK, butyl acetate, cellusolve, toluene, other (specify)

[§] Normal operating period - hrs/day, days/wk, and wk/yr. If the approximate percent seasonal operational differs from that on Page A, please indicate.

Figure D-6. Example Questionnaire-Protective or Decorating Coatings Form.

FABRIC OR RUBBERIZED COATING APPLICATION

1. Materials Coated ________________

2. Type and Amount of Coating Used:

County Permit Number	Application Method*	Type of Coating†	Amount of Coating (Gal/Yr)	Type and % of Major Solvents		Type and Amount of Solvents Added (Gal/yr)		Method of Drying- (Air, Heat Treated)	Normal Operating§		
									Hr	Day	Week
EXAMPLE				Toluene	60%	Toluene	200	Air			
P99999	Lamination	PVC	1000	Xylene	40%				8	5	50

3. Type of Cleaning Solvent ________________, Amount __________ Gal/Yr

mpregnation, "wet" coating, hot melt coating, lamination

olyvinyl chloride, polyurethanes, etc.

oluene, naptha, mineral spirits, MEK, xylene, chlorinated hydroacrbon, other (specify)

ormal operating period - hrs/day, days/wk, wks/yr. If the approximate percent seasonal operation differs from that given on Page A, please indicate.

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Figure D-7. Example Questionnaire-Fabric or Rubberized Coatings Form.

MISCELLANEOUS SURFACE COATING APPLICATION
(ADHESIVES, PAPER, LEATHER, FILM, GLASS, ETC.)

1. Materials Coated ______________

2. Type and Amount of Coating Used:

County Permit Number	Application Method*	Type of Coating†	Amount of Coating (Gal/Yr)	Type and % of Major Solvents§		Type and Amount of Solvents Added (Gal/yr)		Method of Drying- (Air, Heat Treated)	Normal Operating¶		
									Hr	Day	Week
EXAMPLE				Toluene	60%	Toluene	200				
P99999	Spray	Adhesive	1000	MEK	40%			Air	8	5	50

3. Type of Cleaning Solvent ______________, Amount ________(Gal

---

*Spray, flow, dip, roller, brush, etc.

†Adhesive type, pigment coating, barrier coating, polymeric coating, inorganic coating, etc., (specify)

§Branched alcohol, linear alcohol, ethyl acetate, toluene, exylene, ethers, MEK, naptha, other (specify)

¶1975 normal operating period - hrs/day, days/wk, and wk/yr. If the approximate percent seasonal operation differs from that given on Page A, please indicate.

Figure D-8. Example Questionnaire-Miscellaneous Surface Coating Application Form.

OVENS AND OTHER HEATED EQUIPMENT
(INCLUDE HEATED DEVICES WITH INTEGRAL OVENS ALREADY REPORTED ON OTHER FORMS)

1. Material Being Dried ______________________

2. Operational Data:

County Permit Number	Operation*	Heating Method†	Heater Rating (Btu/hr) and Temp (°F)	Permit Numbers of Spray Booth(s) or Coater(s) Feeding Oven	Normal Operating§		
					Hr	Day	Week
EXAMPLE P99999	Batch	Gas (IF)	10,000 700 °F	P99998 P99997	8	5	50

*Batch or continuous

†Electric, steam, waste heat or gas. If gas fired, specify: Indirect-Fired (IF) products of combustion not mixed with oven gases. Direct-Fired Fresh Makeup (DFFM) products of combustion mixed with oven gases. Direct-Fired Recirculation (DFR) oven gases used as combustion air supply.

§Normal operating period.

Figure D-9. Example Questionnaire-Ovens and Heating Equipment Form.

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PRINTING

1. Material Being Coated ______________________

2. Type of Printing Process and Amounts of Solvents Used:

County Permit Number	Printing Process[*]	Type of Ink[†]	Amount (Gal/Yr)	Type and % Major Solvents In Ink[§]		Type and Amounts of Solvents Added (Gal/Yr)[§]		Normal Operating[#]		
								Hr	Day	Week
EXAMPLE P99999	Flexigraphic	Alcohol Solvent Based	2000	Isopropanol	70	MEK	100	8	5	50
				Methanol	15					
				Ethanol	15					

3. Type & Amount Cleaning Solvent Used ______________ Amount ____________ Gal/Yr

[*] Letterpress, flexographic, lithographic, gravure, screen

[†] Solvent based, oil based, lacquer type, etc.

[§] Isopropyl alcohol, ethanol, propanol, naptha/mineral spirits, toluene, MEK, other (specify)

[#] Normal operating period - hrs/day, days/wk, wks/yr. If the approximate percent seasonal operation differs from that given on Page A, please indicate.

Figure D-10. Example Questionnaire-Printing Form.

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GENERAL SOLVENT USAGE

Type and amount of other solvents not identified with equipment having a county permit that were used at your facility during calendar year

Do not include any solvents that have been included elsewhere in this questionnaire.

TYPE	AMOUNT (GAL/YR)
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

SOLVENT RETURNED

List any solvents returned to supplier or collected for reprocessing. Again, do not include any solvents that have been so specified elsewhere in this questionnaire.

TYPE	AMOUNT (GAL/HR)
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

Figure D-11. Example Questionnaire-General Solvent Usage Form.

BULK SOLVENT STORAGE

Complete the following information for each storage tank greater than 250 gallons capacity. **(See Editorial Note below)**

Tank No.	Solvent Type	Capacity	Annual Thruput	Type of Fill and Control Equipment*

* Submerged fill, splash fill, return vent line, adsorber.

OPERATIONAL MODIFICATIONS

Please state the changes in type and estimated annual consumption of solvent planned for all operations for calendar years __________. Include any information on control equipment additions or modifications.

(Editorial Note: This questionnaire should contain space for two additional pieces of information: tank color and tank condition. The reader is reminded that these questionnaires are provided as examples and not as recommended procedures.)

Figure D-12. Example Questionnaire-Bulk Solvent Storage Form.

CONTROL AND STACK INFORMATION

INSTRUCTIONS:

1. Provide information on all devices that emit organic compounds through a stack, vent or other defined emission point. Identify all units under separate permits that vent through a common stack. A simple drawing may be provided to better illustrate the physical configuration.
2. Identify the primary organic compound control method used (if any) such as after burners, scrubbers, carbon adsorption, condensers, etc. Note: this device may have its own permit number. If so, identify.
3. Indicate installation date of control equipment.
4. Indicate approximate efficiency (if known).
5. Provide the following information:

Height - distance above ground to discharge point (feet)
Diameter - inside diameter at discharge point (feet)
Note: if not circular, insert diameter (in feet) of equivalent circular area which can be calculated by

$$D_e = 1.128\ A$$

where A is the measured or estimated cross-sectional area in sq ft and D_e is the equivalent diameter.
Temperature - at discharge point in °F
Velocity - at discharge point in ft/sec
Flow rate - at discharge in actual cubic feet per minute (ACFM)

Design conditions may be used in lieu of actual test data.

County Permit Number	HC Control Eqmt	Control Eqmt Effic. (%)	Installation Date	Stack Data				
				Height (ft)	Inside Dia. (ft)	Temp (°F)	Velocity (ft/sec)	Flow Rate (ft^3/min)
EXAMPLE P99999	After-burner	95	1969	20	1.5	600	20	2100

Figure D-13. Example Questionnaire-Control and Stack Information Form.

APPENDIX E - SUPPLEMENTRY INVENTORY DOCUMENTATION DATA DISPLAYS

This appendix provides VOC emission inventory documentation data displays which are intended to supplement the documentation discussed in Chapter 7. The following examples are not intended to be exclusive, but rather, they should act as primers to promote ideas of how an inventory can be documented.

The first three figures require little explanation. Figure E-1 shows the reader what geographical area is covered by the inventory. Population data are presented in Figure E-2. Figure E-3 is an example highway network map. This will help persons unfamiliar with the inventory area in assessing traffic data and other documentation associated with highway vehicle emissions estimates.

The next four documentation examples relate to emissions projections and control strategy impact assessment. Figure E-4 shows what years specific control programs will be applied to the projection year inventories. This will support the application of control program emissions reductions to specific years. Quantitative impact of control programs on projected emissions is shown in Figures E-5 and E-6. Figure E-5 illustrates the incremental reductions associated with individual control strategies. Figure E-6 documents the cumulative effect of control programs on projected emissions. Figure E-7 is a listing of control measures planned in an inventory area. Such a listing will help support the programming of emissions reductions into projection year inventories.

Finally, the last figure in this Appendix is an example of questionnaire response documentation. Some documentation of this type should be included in the emissions inventory support materials.

Many additional items can and should be included in the emissions inventory documentation. The example figures provided in this appendix are not inclusive of all forms of documentation. The reader should review the discussion documentation in Chapter 7 prior to developing documentation materials.

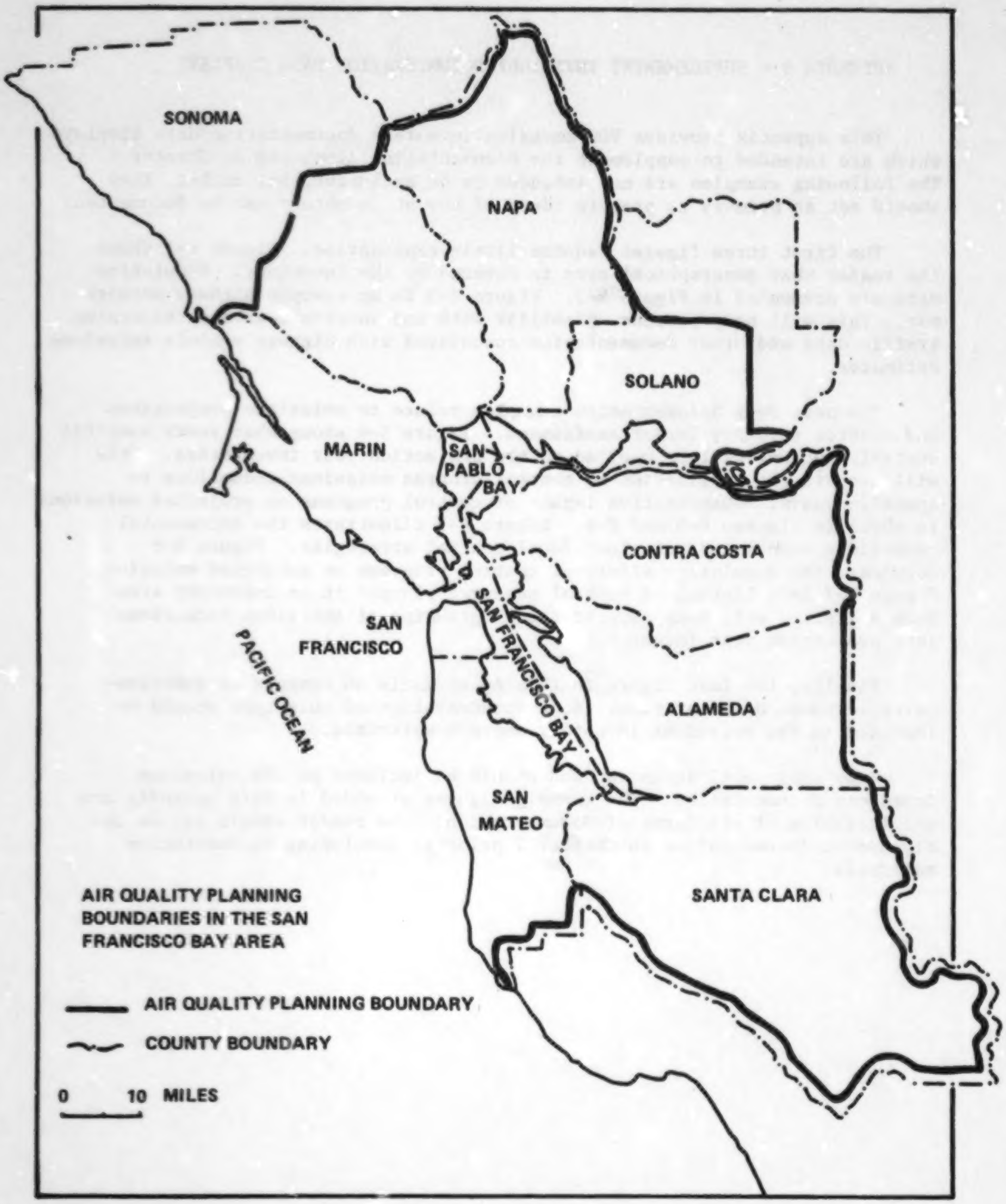

SONOMA
NAPA
SOLANO
MARIN
SAN PABLO BAY
CONTRA COSTA
SAN FRANCISCO
PACIFIC OCEAN
SAN FRANCISCO BAY
ALAMEDA
SAN MATEO
SANTA CLARA
AIR QUALITY PLANNING BOUNDARIES IN THE SAN FRANCISCO BAY AREA
AIR QUALITY PLANNING BOUNDARY
COUNTY BOUNDARY
0
10 MILES

Figure E-1. Example VOC emissions inventory map.

Figure E-2

TOTAL POPULATION AND PERCENT OF TOTAL
BY AGE GROUPS BY COUNTY AND HSA*
FLORIDA AND UNITED STATES FOR
1970 - 1975

Area	Year	ALL AGES		0 - 14		15 - 25		25 - 44		45 - 64		65 & OVER	
		Total #	%	Total #	%	Total #	%	Total #	%	Total #	%	Total #	%
HILLSBOROUGH COUNTY	1970	490,265	100.0	137,456	28.0	84,707	17.3	116,533	23.8	100,383	20.5	51,106	10.4
	1971	500,500	100.0										
	1972	531,458	100.0										
	1973	563,461	100.0	145,564	25.9	101,959	18.1	144,558	15.7	111,241	19.8	59.140	10.5
	1974	586,792	100.0	149,508	25.4	105,212	17.9	154,858	26.3	115,306	19.6	63,910	10.9
	1975	605,597	100.0	148,182	24.5	111,082	18.3	162,866	26.9	119,236	19.7	64,231	10.6
MANATEE COUNTY	1970	97,115	100.0	18,739	19.3	10.978	11.3	15,598	16.0	22,569	23.2	29,331	30.2
	1971	100,500	100.0										
	1972	106,245	100.0										
	1973	108,200	100.0	19,225	17.8	12,735	11.8	16,660	15.4	23,753	22.0	35,827	33.1
	1974	117,642	100.0	19,883	16.9	12,425	10.6	16,876	14.3	24,619	22.9	43,840	37.3
	1975	123,506	100.0	19,676	15.9	13,708	11.1	17,856	14.5	25,897	21.0	46,369	37.5
PASCO COUNTY	1970	75,955	100.0	13,247	17.4	8,279	10.9	10,791	14.2	19,617	25.8	24,021	31.6
	1971	81,000	100.0										
	1972	96,883	100.0										
	1973	110,052	100.0	19,307	17.5	11,859	10.8	16,994	15.4	29,153	26.5	32,739	29.7
	1974	123,199	100.0	20,054	16.3	15,258	12.4	20,275	16.5	30,935	25.1	36,676	29.8
	1975	130,190	100.0	19,891	15.3	13,257	10.2	18,507	14.2	31,573	24.3	46,962	36.1
PINELLAS COUNTY	1970	522,329	100.0	98,074	18.8	59,075	11.3	86,736	16.6	124,521	23.8	153,923	29.5
	1971	536,329	100.0										
	1972	591,093	100.0										
	1973	620,103	100.0	105,983	17.1	72,901	11.8	102,089	16.5	146,339	23.6	192,793	31.1
	1974	649,852	100.0	107,037	16.5	75,233	11.6	103,286	15.9	146,252	22.5	218,047	33.6
	1975	666,595	100.0	104,609	15.7	78,904	11.8	102,297	16.1	151,462	22.7	224,323	33.7
HSA IV **	1970	1,185,664	100.0	257,516	21.7	163,039	13.8	229,558	19.4	267,090	22.5	258,461	21.8
	1971	1,218,600	100.0										
	1972	1,325,679	100.0										
	1973	1,400,816	100.0	290,079	20.7	199,454	14.2	280,301	20.0	310,486	22.2	320,499	22.9
	1974	1,479,485	100.0	296,482	20.0	208,128	14.1	295,295	20.0	317,112	21.4	362,473	24.5
	1975	1,525,888	100.0	292,358	19.2	216,951	14.2	306,526	20.1	328,168	21.5	381,085	25.0
FLORIDA	1970	6,789,443	100.0	1,752,639	25.[illegible]	1,074,626	15.8	1,509,672	22.2	1,466,816	21.6	985,690	14.5
	1971	7,025,100	100.0										
	1972	7,441,500	100.0										
	1973	7,845,093	100.0	1,826,268	23.3	1,295,634	16.5	1,776,550	22.6	1,693,155	21.6	1,253,487	16.0
	1974	8,248,851	100.0	1,852,045	22.5	1,356,820	16.4	1,841,900	22.3	1,755,985	21.3	1,442,099	17.5
	1975	8,485,230	100.0	1,836,332	21.6	1,401,546	16.5	1,899,550	22.4	1,833,883	21.6	1,513,879	17.8
UNITED STATES (1,000's)	1970	203,235	100.0	57,865	28.5	36,461	17.9	48,024	23.6	41,837	20.5	19,972	9.9
	1971	207,045	100.0	57,526	27.8	37,810	18.3	48,809	23.6	42,413	20.5	20,487	9.9
	1972	208,842	100.0	56,717	27.2	38,203	18.3	50,250	24.1	42,789	20.5	20,883	10.0
	1973	210,404	100.0	55,697	26.5	38,882	18.5	51,412	24.4	43,084	20.5	21,329	10.1
	1974	211,909	100.0	50,386	23.8	43,786	20.7	52,593	24.8	43,328	20.4	21,815	10.3
	1975	213,137	100.0	49,352	23.2	44,299	20.8	53,542	25.1	43,544	20.4	22,400	10.5

SOURCE: University of Florida, Bureau of Economic and Business Research; Population Studies; U.S. Department of Commerce, Bureau of the Census Statistical Abstract of the United States

*HSA: Florida Gulf Health Systems Agency

**HSA IV: Region IV serving Pinellas, Pasco, Hillsborough and Manatee Counties in Florida

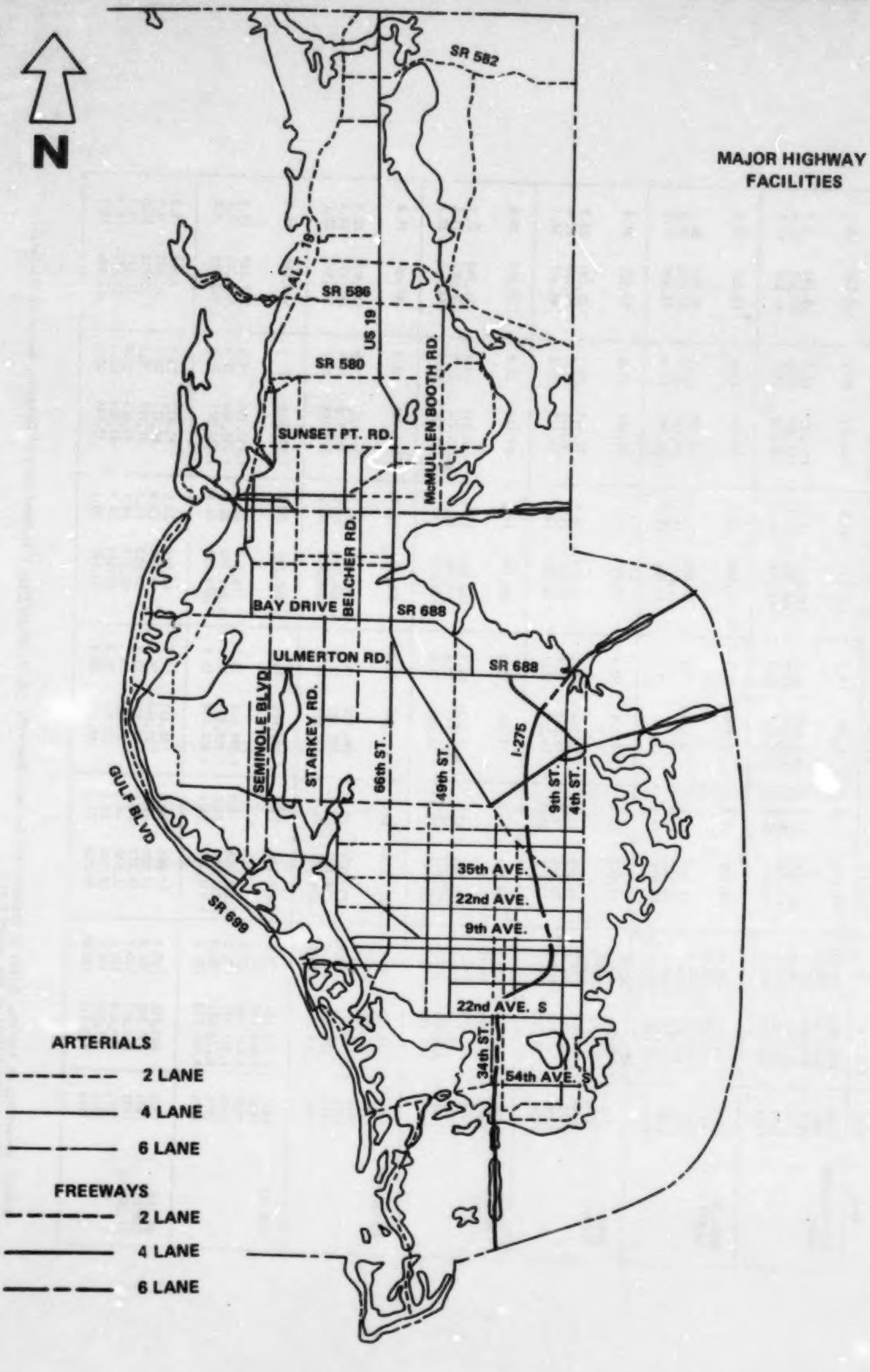
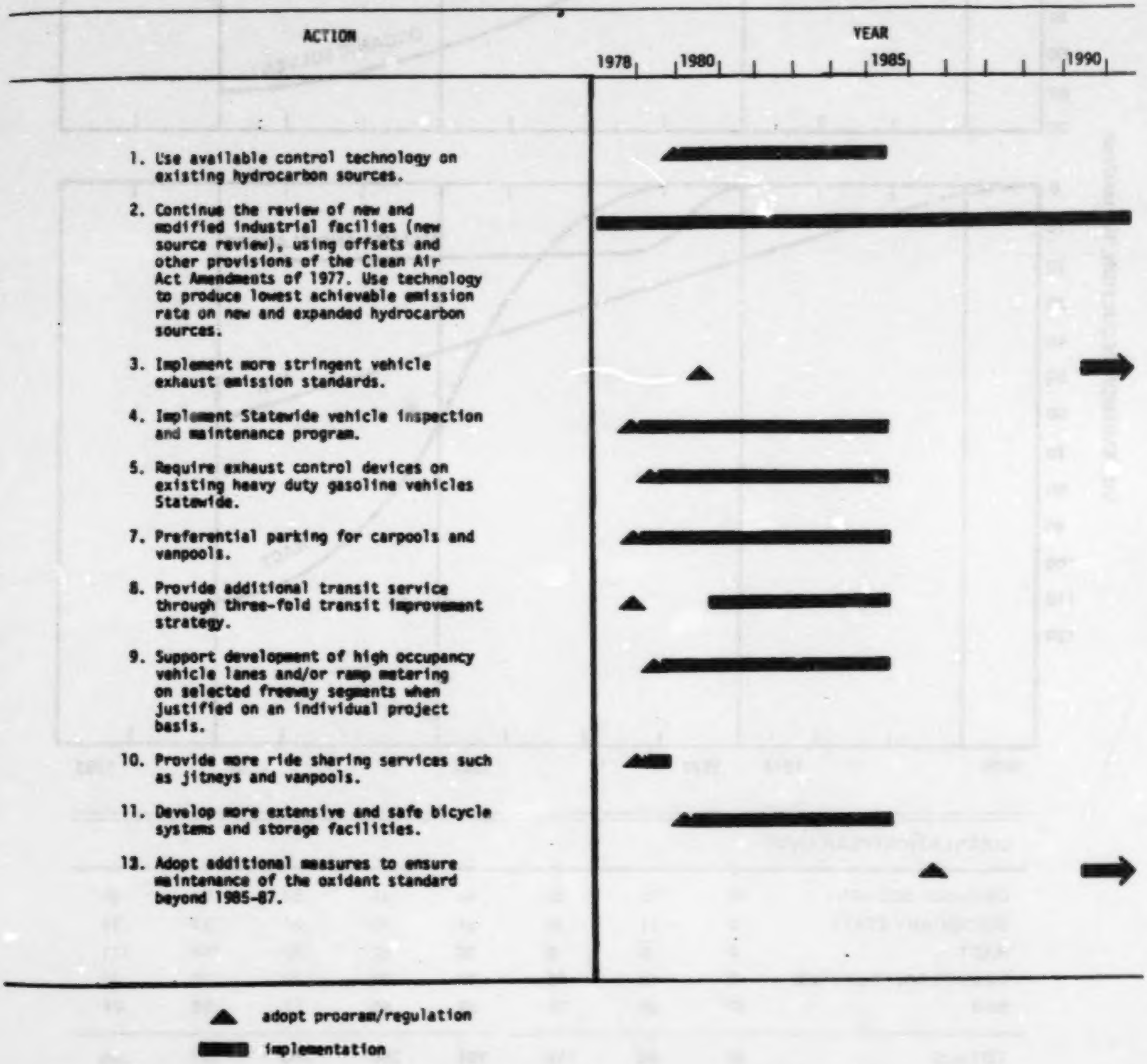

N
MAJOR HIGHWAY FACILITIES
SR 582
ALT. 19
SR 586
US 19
SR 580
McMULLEN BOOTH RD.
SUNSET PT. RD.
BELCHER RD.
BAY DRIVE
SR 688
ULMERTON RD.
SR 688
SEMINOLE BLVD
STARKEY RD.
66th ST.
49th ST.
I-275
9th ST.
4th ST.
GULF BLVD
35th AVE.
22nd AVE.
9th AVE.
SR 699
22nd AVE. S
34th ST.
54th AVE. S
ARTERIALS
2 LANE
4 LANE
6 LANE
FREEWAYS
2 LANE
4 LANE
6 LANE

Figure E-3. Example highway network map.

Figure E-4 SCHEDULE FOR IMPLEMENTATION OF THE AIR QUALITY MAINTENANCE PLAN



1. Use available control technology on existing hydrocarbon sources.

2. Continue the review of new and modified industrial facilies (new source review), using offsets and other provisions of the Clean Air Act Amendments of 1977. Use technology to produce lowest achievable emission rate on new and expanded hydrocarbon sources.

3. Implement more stringent vehicle exhaust emission standards.

4. Implement Statewide vehicle inspection and maintenance program.

5. Require exhaust control devices on existing heavy duty gasoline vehicles Statewide.

7. Preferential parking for carpools and vanpools.

8. Provide additional transit service through three-fold transit improvement strategy.

9. Support development of high occupancy vehicle lanes and/or ramp metering on selected freeway segments when justified on an individual project basis.

10. Provide more ride sharing services such as jitneys and vanpools.

11. Develop more extensive and safe bicycle systems and storage facilities.

13. Adopt additional measures to ensure maintenance of the oxidant standard beyond 1985-87.

▲ adopt program/regulation

▬ implementation

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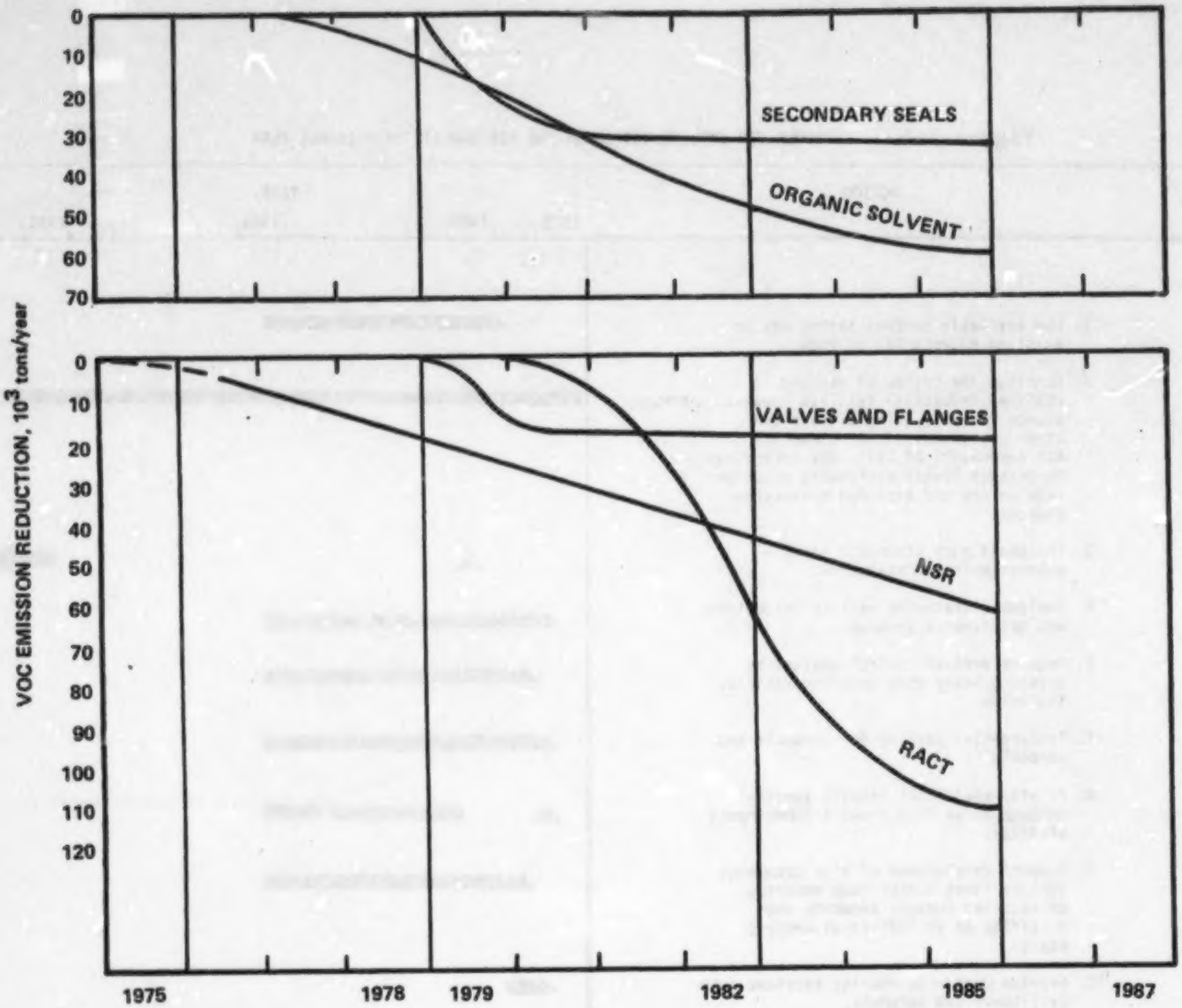

COMPILATION(YEAR END)								
ORGANIC SOLVENT	10	20	30	40	48	54	58	60
SECONDARY SEALS	0	21	29	31	32	33	33	34
RACT	0	0	6	26	62	82	107	111
VALVES AND FLANGES	0	13	18	18	18	19	19	20
NSR	20	26	32	39	45	52	58	64
TOTALS	30	80	115	154	205	250	275	289

Figure E-5. Example schedule for quantified stationary source organic emissions reductions.

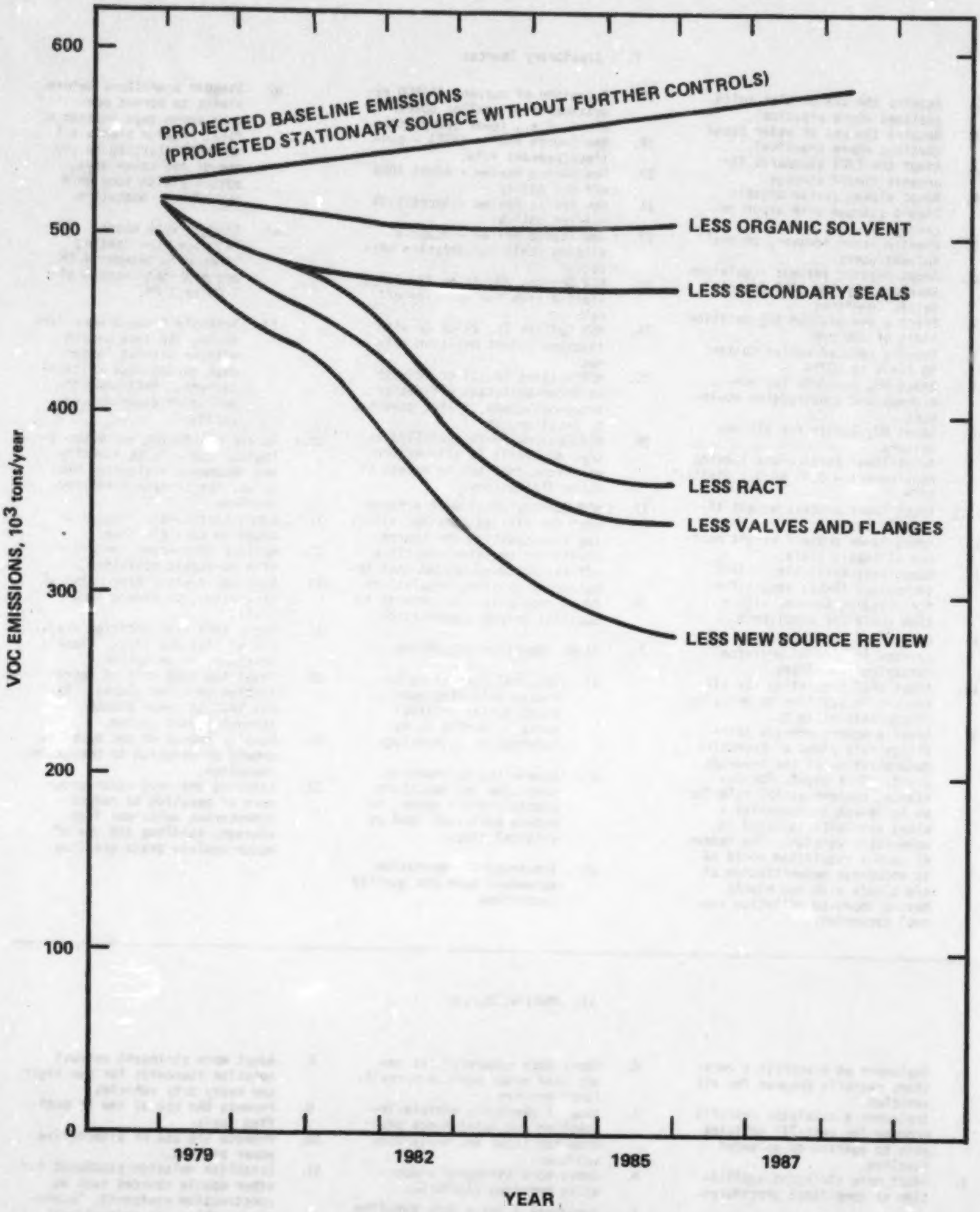

Figure E-6. Example graph of control measures impact on projected emissions.

Figure E-7 Example Listing of Control Measures

I. Stationary Sources

1. Require the use of high solid coatings where practical.
2. Require the use of water based coatings where practical.
3. Adopt the CARB standards for organic liquid storage.
4. Adopt closed system organic liquid storage with vapor recovery.
5. Require vapor recovery on small solvent users.
6. Adopt organic solvent regulation developed by the CARB Organic Solids Committee.
7. Enact a new maximum SO_2 emission limit of 300 ppm.
8. Require reduced sulfur content in fuels to .025%.
9. Adopt NO_x controls for non-highway and construction equipment.
10. Adopt NO_x limits for all new boilers.
11. Adopt lower particulate loading requirement - 0.05 to 0.1 grains/SCFM.
12. Adopt lower process weight allowable scale.
13. Adopt lower process weight maximum allowable scale.
14. Adopt best available control technology (BACT) regulation for existing sources with a time scale for compliance.
15. Adopt BACT regulation for all sources in lieu of emission concentration limits.
16. Adopt BACT regulation for all sources in addition to emission concentration limits.
17. Adopt a modern process technology rule aimed at promoting modernization of the areawide plant. This might, for instance, suspend a BACT rule for an agreement to modernize a plant with BACT included in modernized version. The intent of such a regulation would be to encourage modernization of old plants with new plants having improved pollution control technology.
18. Extention of current BAAPCD requirements to smaller operations, i.e., fewer exemptions.
19. New Source Review (NSR) - continue present rule.
20. New Source Review - Adopt 100% off-set policy.
21. New Source Review - Adopt 110% off-set policy.
22. New Source Review - Adopt a sliding scale for emission off-set.
23. NSR Options 20, 21 or 22 with a limited area for emission off-set.
24. NSR Options 20, 21 or 22 with inter-pollutant emission off-set.
25. NSR Options 20, 21 or 22 with no inter-pollutant off-set or inter-pollutant off-set governed by location, etc.
26. NSR Options 20-25 qualified so that no credit is allowed for emissions that are in excess of other limitations.
27. NSR Options 20-25 with arrangement for off-set banking, allowing a prospective new source credit for emission reduction off-set achieved beyond that required by existing regulations.
28. Adopt regulations to promote industrial energy conservation.
29. Plant operation scheduling:

    a) Seasonal scheduling to reduce polluting operations during critical weeks or months as determined by meteorology.

    b) Scheduling maintenance down time and vacations, possibly short downs, to reduce pollutant load at critical times.

    c) Interruptable operation dependent upon air quality conditions.

    d) Stagger operations between plants to spread operation over seven days instead of five. Assign plants a 5 day week starting on any-one of the seven days, possibly with some on 4 day 10-hour operation.

    e) Stagger work hours. For instance, run coating lines only between 4 PM and midnight instead of 7 AM to 3 PM.

    f) Schedule reduced work days during the smog season with or without longer days during less critical seasons. Rationing the pollution absorbing capacity.
30. An air monitoring and meteorological analysis to identify and recommend mitigation measures, for certain localized problems.
31. Adopt particulate regulation based on particle size.
32. Replace throw-away container with re-usable containers.
33. Burn solid waste near point of generation, to reduce long hauls.
34. Apply 1309 with modified trade-off of 1311 and 1311-2 clearly described as an option.
35. Requiring some sort of retrofitting on older plants. Apply BACT to newer plants through permit system.
36. Penalty charge or tax based on amount of emission to encourage reduction.
37. Lowering the reid vapor pressure of gasoline to reduce hydrocarbon emissions from storage, handling and use of motor vehicle grade gasoline.

II. Mobile Sources

1. Implement an evaporative emissions retrofit program for all vehicles.
2. Implement a catalytic retrofit program for past-71' vehicles able to operate on unleaded gasoline.
3. Adopt more stringent application of compliance procedures.
4. Adopt more comprehensive new and used motor vehicle surveillance program.
5. Adopt a mandatory vehicle inspection and maintenance program for light and heavy duty vehicles.
6. Adopt more stringent evaporative emission standards.
7. Implement a heavy duty gasoline exhaust emission retrofit program.
8. Adopt more stringent exhaust emission standards for new light and heavy duty vehicles.
9. Promote the use of new or modified fuels.
10. Promote the use of alternative power sources.
11. Establish emission standards for other mobile sources such as construction equipment, locomotives, ships, or recreational vehicles.

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Figure E-7 (ctd.)

III. Transportation Controls

1. Measures to Improve Traffic Operations
   - A. Improve Traffic Flow
     - 1) Computerized traffic control
     - 2) Ramp Metering
     - 3) Traffic engineering improvements
     - 4) Off-street freight loading
   - B. Reduce peak-period traffic volumes
     - 1) Staggered work hours
     - 2) Four day work week
     - 3) Off-peak freight delivery
2. Measures to Reduce Vehicle Use
   - A. Restrict Vehicle Ownership
     - 1) Additional license fee
     - 2) Registration limits
   - B. Management of Auto Access
     - 1) Better enforcement of parking regulations
     - 2) Limit on number of parking spaces
     - 3) On-street parking prohibited during peak hours
     - 4) Area license
     - 5) Auto-free zones
     - 6) Gas rationing
   - C. Increase Cost of Auto Use
     - 1) Road pricing
     - 2) Increased parking costs
     - 3) Parking fee for shopper
     - 4) Eliminate free employee parking
     - 5) Increased gas tax
     - 6) Increased tolls
     - 7) "Smog charges"
   - D. Reduce the Need to Travel
     - 1) Communications substitutes
     - 2) Goods movement consolidation
3. Measures to Encourage Alternative Model of Travel
   - A. Increase Transit Ridership
     - 1) Additional transit service
     - 2) Fare reductions
     - 3) Improved comfort
     - 4) Bus and carpool lanes
   - B. Encourage Pedestrian Mode
   - C. Encourage Bicycle Mode
   - D. Encourage Ride Sharing
     - 1) Toll reduction for carpools
     - 2) Preferential parking and carpools
     - 3) Carpool matching information
     - 4) Assist vanpool formation
   - E. Promote Para-Transit Alternatives

IV. Land Use Management/ Development Controls

More effective management of all five major aspects of land development through coordinated action by cities, counties, special districts, or regional and State agencies to reduce the magnitude and frequency of auto travel:

1. Timing - expand the presently very limited application of timing controls such as growth sequence zoning, building permit quotas, staging of sewer and water intrastructure and plant capabilities, etc.
2. Quantity - expand the presently scattered application of quantitative controls on development such as performance standard zoning and limited sewer and water infrastructure and plant capacities.
3. Location - Improve the presently inconsistent application of controls on the location of development such as coordinated management of infrastructure location, annexations, public land acquisition, agricultural preserves, hillside and soil conservation, and development moratoria.
4. Density - Encourage transit usage and other non-auto modes with coordinated density policies among local jurisdictions through the application of innovative density zoning mechanisms (slope density, building height regulations, etc.) fully coordinated with service capacities and commitments.
5. Type - Reduce home-to-work & home-to-non-work travel by encouraging more land use mix, especially in terms of housing/jobs balance.

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Figure F-8 QUESTIONNAIRE SURVEY RESPONSES BY COUNTY

	Response Distribution								
State/County	Total Companies Queried	Delete	Miscellaneous	Out of Business	No Response	Returned to Sender	User of VOC	Nonuser of VOC	Number of Point Sources
Oregon									
Clackamas	281	6	9	10	60	27	76	93	4
Multnomah	1,754	52	57	41	336	191	527	550	39
Washington	270	4	6	6	52	27	89	86	5
Washington									
Clallam	61	4	0	0	15	4	24	14	1
Clark	189	0	10	2	46	17	57	57	5
Cowlitz	98	2	2	5	26	9	27	27	4
King	2,371	53	76	38	631	203	648	722	15
Kitsap	106	2	6	1	29	9	38	21	3
Pierce	491	8	19	3	125	59	146	131	6
Skagit	73	1	4	2	9	5	30	22	0
Snohomish	298	1	11	8	79	21	99	79	4
Spokane	481	5	21	17	85	46	190	117	8
Whatcom	136	1	3	9	21	8	46	48	2
Survey Area Total	6,609	139	224	142	1,514	626	1,997	1,967	96

APPENDIX F - EPA EMISSIONS DATA SYSTEMS

F-1 NATIONAL EMISSIONS DATA SYSTEM (NEDS)

The National Emissions Data System is a computerized data handling system which accepts, stores and reports on source and emissions information relating to any of the five criteria pollutants (Total Suspended Particulate, SO_2, NO_x, CO and Hydrocarbons). In NEDS, a major distinction is made between point sources and area sources. Although by EPA definition (40 CFR 51), point sources are any facilities that emit more than 100 tons/year, they are in the broadest sense, stationary sources large enough to be identified and tracked individually. Area sources, on the other hand are those stationary and mobile sources which individually emit less than 100 ton/year and are too small and too numerous to keep individual records on. Area sources are compiled collectively on a county basis. A large boiler within a power plant would be an example of a point source, whereas a single automobile is an example of the type of source collectively considered an area source.

In NEDS, all source related data are entered into the system on specially formulated point and area source coding forms and are stored in separate point and area source files. Point and area source are data stored in the system are briefly described below.

Point Source Data -

General source information: Name, address, source type, year of record, comments, etc.

Emissions data: Operating or production rate, estimated emissions, EPA calculated emissions, control device type and efficiency for each criteria pollutant, etc.

Modeling parameters: UTM coordinates, stack height and diameter, exhaust gas temperature, flow rate, etc.

Area Source Data -

General source information: Name and location of area (county) source, year of record.

Activity levels: Countywide activity levels of each type of area source (e.g., tons of coal burned in all domestic space heating equipment in a county).

Emissions data: Emission estimates for the entire county, for each pollutant and for each area source category.

Currently in NEDS, information is being maintained on over 55,000 point sources (plants) and about 3,100 area (county or county equivalent) sources in the 55 states and territories of the United States. The point source total will fluctuate as additional sources are reported, new sources come into operation, or old sources cease operations. The number of area sources is fixed by the number of counties in the United States.

The information contained in these files changes, too. As plants add to, modify, or change the operation of their equipment, use different fuels, etc., the point source data must be continually updated to reflect these changes. Likewise, as the activity levels of the various area sources change (more vehicle miles may be traveled by automobiles in a county, more oil and less gas may be burned for home heating, etc.) their records must likewise be updated. By EPA requirement (40 CFR 51), it is the responsibility of the states to maintain point source data. Area source data, because of their composite nature, are collected, apportioned, and maintained centrally by EPA, although state supplied data will be accepted if they are more accurate and adequately documented. All submitted data are edited and validated prior to being accepted into the system. In addition to the point and area source files, NEDS emission factor files are kept current with the latest AP-42 information.

The most important function of NEDS is report generation. NEDS output ranges from reports on individual point and area sources to sophisticated summaries which aggregate data in a variety of ways and condense data from many sources into one report. Also, because of the NEDS file design numerous selection and sorting criteria can be specified by the users of the system.

The following describes the more important reports available from NEDS. This is not a complete list, since NEDS is continually being expanded to meet additional user needs.

Complete point or area source listing - These reports include, in a standard format, all of the source and emissions data sorted in NEDS for individual point or area sources. This includes all of the data supplied to NEDS on point and area source input forms, as well as any emission estimates calculated by EPA through the use of emission factors.

Condensed point source listing - This report yields an abbreviated listing of data items for each point source, including the plant name, location, control device and efficiency, and the emissions associated therewith.

Emissions summary report - This report lists, for a specific geographical area, emissions of each of the criteria pollutants associated with all of the source categories represented in NEDS, as well as the total emissions for all source categories.

Plant emissions report - This report presents a listing of the names of plants in NEDS and the emissions associated with each plant.

Fuel summary listing - This report tallies the type and amount of fuel consumed by all stationary and mobile source categories for a specified geographical area. This report includes both point and area source records.

Quick look report - This is a one line report for selected NEDS point or area sources. Only data items printed which are specified by the user.

Emissions by SCC (Source Classification Code) report - This report shows each SCC, the number of times that SCC occurs within a specified geographical area, and the total emissions for each of the five pollutants associated with each SCC. (Note that a SCC number is a code used in NEDS to represent different kinds of point source categories.)

NEDS is currently operational on a UNIVAC 1110 located at Research Triangle Park, NC. It is accessible in interactive and remote batch modes by EPA headquarters and regional personnel. The system is not routinely available to users as a software package to be run on their own computers. However, descriptions, flow charts, and other documentation are available in the AEROS Manual Series publications that are obtainable from EPA to qualified requesters and, for others, from the National Technical Information Center (NTIS), 5285 Port Royal Road, Arlington, VA 22161. Consult the AEROS/NEDS contact in the appropriate EPA Regional Office for further details and assistance in obtaining the proper publications and information.

F-2 THE EMISSIONS INVENTORY SYSTEM/PERMITS AND REGISTRATION SUBSYSTEM (EIS/P&R) OF THE COMPREHENSIVE DATA HANDLING SYSTEM (CDHS)

The Comprehensive Data Handling System (CDHS) is intended to aid State and local air pollution control agencies in performing their daily operations and to ease their job of meeting EPA reporting requirements.

The CDHS actually comprise two basic and important subsystems which may be operated independently. These subsystems are:

The Emissions Inventory/Permits and Registration Subsystem (EIS/P&R)
The Air Quality Data Handling Subsystem - II (AQDHS-II)

The CDHS subsystems (software) are provided to state and local air pollution control agencies at no charge. Each agency installs the subsystems on a computer to which it has access. The agency can then build and maintain its own data base. The computer programs which comprise each subsystem are maintained by EPA. Of these, EIS/P&R is of interest in the context of emission inventories.

The EIS/P&R subsystem provides a means for monitoring point and area source engineering and emissions data. It has special capabilities for recording permit data, and it can handle narrative information such as rules and regulations. EIS/P&R also provides means for handling special data of local importance while maintaining full compatibility (for reporting purposes) with Federal requirements. EIS/P&R is especially significant, since it can be used to support such agency activities as permit control, source inventory, legal actions, and the monitoring and recording of enforcement and inspection activities. A simplified diagram of the basic concept of EIS/P&R is shown in Figure F-1.

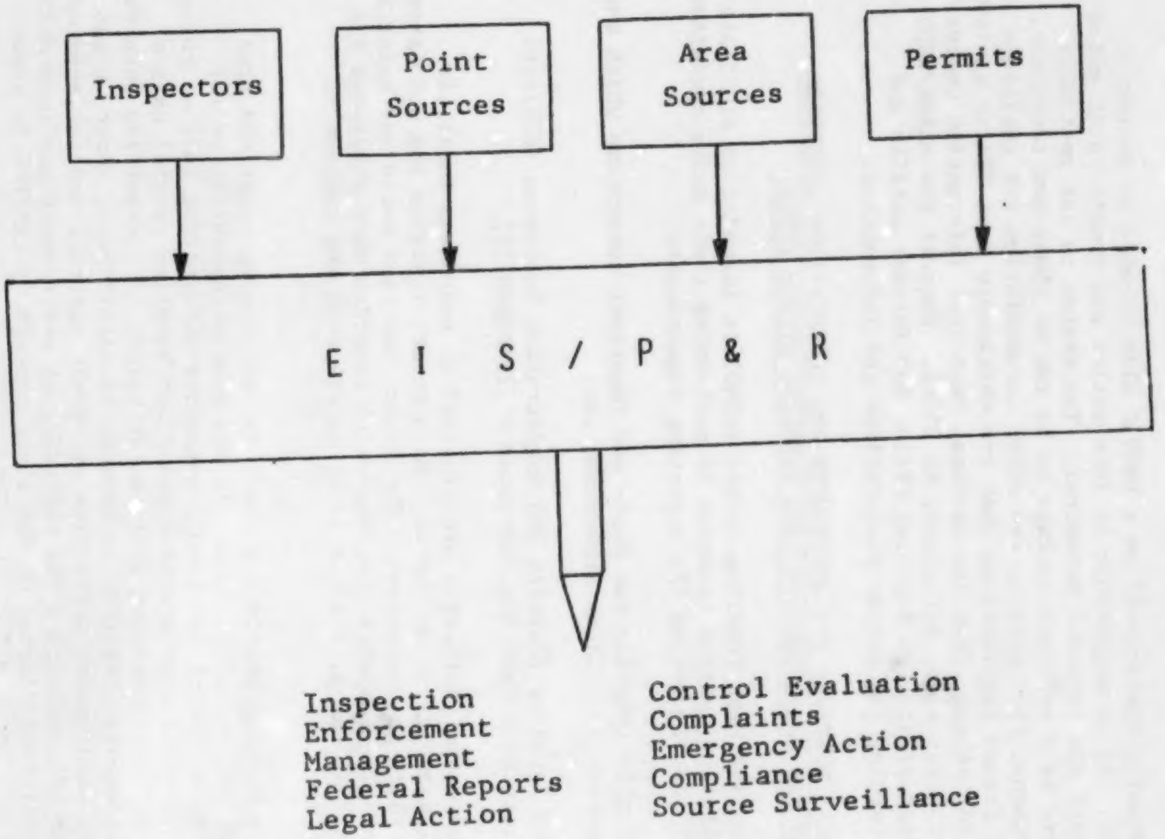
Inspectors
Point Sources
Area Sources
Permits
E I S / P & R
Inspection
Enforcement
Management
Federal Reports
Legal Action
Control Evaluation
Complaints
Emergency Action
Compliance
Source Surveillance

Figure F-1. EIS/P&R Concept.

The interested agency should consult the appropriate EPA Regional Office for more information on what EIS/P&R can do and how to obtain it. It may also contact the National Air Data Branch, (MD-14), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.